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High-Intensity Training: How-To Program for Best Results and Avoid Overtraining.

Amy Ashmore, PhD

Learner Outcomes

After this course, participants will be able to:

- Develop high-intensity strength training sessions and programs.
- Modify high-intensity strength workouts and programs based on individual response to activity.
- Identify at least three symptoms of overtraining.
- Identify at least two common high-intensity training methods that can cause rhabdomyolysis.
- Incorporate current rest and recovery guidelines into high-intensity strength programming for improved results and decreased overtraining.
- Define rhabdomyolysis and recognize common high-intensity training methods that can cause it.
- Incorporate current rest and recovery guidelines into high-intensity programming for optimal results and avoid overtraining.

CONTINUED

Course Outline

I. Periodization training and programming variables.
II. High-intensity training.
   I. Define.
   II. Methods.
III. High-intensity training programming.
   I. Circuits.
   II. Supersets.
   III. Combined training.
   IV. Complex training.
IV. Training load.
V. Overtraining.
   I. Rhabdomyolysis.
   II. Prevention through programming.
VI. Programming with rest and recovery.

CONTINUED

Periodization

CONTINUED

Periodization Training

- Successful periodization training is based on timing exercise programming variables correctly over approximately a year to achieve peak performance at the right time.
- In fitness and rehabilitation we use the same variables, albeit with an acknowledgement that we are typically dealing with much shorter time frames and different goals and outcomes.

CONTINUED

Programming Variables

1. Mode (type of training).
2. Frequency (recurrence of sessions; recovery lengths).
3. Duration (length of program, each session total, and session components).

CONTINUED

Programming Variables

4. Volume (how much; sets and reps; distance and time).

5. Intensity (how hard; heart rate; MFGC or output).

CONTINUED

Measuring Muscle Force

- Muscle force generation capacity (MFGC).
- A direct measurement of muscular strength.
- Used for all populations.

CONTINUED

High-Intensity Training

CONTINUED

High-intensity (interval) training (HIIT) is the number one exercise trend worldwide for 2018 according to the American College of Sports Medicine.

Thompson, W. 2017

CONTINUED

What is HIT?

1. Cardiovascular exercise.
2. Resistance exercise.
3. Combination of both.

CONTINUED

Programming

Three key programming variables associated with HIT are:

1. Intensity (how hard).
2. Volume (how much or how long).
3. Rest periods.

CONTINUED

Intensity-Volume Dynamic

- Intensity and volume are inversely related.
- The higher the intensity of the exercise the shorter the all-out work or high-intensity interval (volume) will be.

CONTINUED

HIT Defined

High-intensity training is defined as exercise sustained at higher than 85% max heart rate for 60 seconds to four minutes.

CONTINUED

Strength

HIT when doing resistance training is defined as muscle work 85% or above 1RM.

CONTINUED

Rest Periods

- Rest is a key factor to safe and effective HIT.
- Rest is accounted for in HIT programming.
- The higher the intensity of the exercise period the longer the rest period will be.

Rest Periods

Rest can include:

- Periods of less intense exercise (for example, low-intensity resistance sets).
- Active recovery like -
  - Dynamic stretching.
  - Swimming.
  - Other low-impact and low-intensity cardiovascular exercise.

HIT Programming

CONTINUED

Intensity

Load

Speed (of contraction)

CONTINUED

Common Methods

- Circuits
- Supersets
  - Strength only
  - Cardio-strength
- Combined Training
- Complex Training (advanced)

CONTINUED

Circuits

- Circuits are a series of exercises in succession.
- Example is a dumbbell squat followed by a ball crunch followed by a standing overhead press.
- Good for beginning exercises.
- Suited for group exercise.

CONTINUED

Circuit Programming

- Three to four sets of 12 -18 repetitions each exercise.
- To increase intensity increase the weight used during each set and /or decrease rest intervals.

CONTINUED

Supersets

- Supersets are doing two exercises back to back. Alternated.
- They are a great way to keep people moving and focus on specific muscles.
- Time efficient.
- Intermediate to advanced exercisers.

CONTINUED

Superset Programming

- Typically, the muscle groups used complement one another –
  - For example, synergist (work together) supersets like a back exercise followed by a biceps exercise.
  - Or, agonist-antagonist supersets like a triceps exercise followed by a biceps exercise.
- Same muscle group(s) supersets are used; however, best for intermediate to advanced exercisers with specific goals.

CONTINUED

Supersets Programming

CONTINUED

Supersets Programming

CONTINUED

Supersets Programming

CONTINUED

Cardio-Strength Supersets

- Alternate cardiovascular training with resistance training.
- For example, walk or jog on an incline on a treadmill for one to five minutes followed by a set of 10 – 18 lunges for each leg.
- Repeat. Rest as necessary; modulate intensity to avoid long rests.

CONTINUED

Supersets Programming

CONTINUED

Cardio-strength Programming

To change the intensity

- Increase of decrease the incline on the treadmill or other mode of cardiovascular exercise.
- Increase of decrease the speed on the treadmill or other mode of cardiovascular exercise.
- Increase or decrease the amount of weight during strength set.

CONTINUED

Cardio-strength Programming

To change the volume –

- Increase of decrease time on the treadmill or other mode of cardiovascular exercise.
- Increase or decrease the number of repetitions and sets for each strength set.

CONTINUED

Sample Cardio-Strength Superset Workout

Exercise	Time/Reps	Speed/Resistance	Rest Between Sets
Cardio Mode of Choice	1 – 3 minutes	TBD	0 – 60 seconds
Dumbbell Squat	10 – 18	TBD	0 – 60 seconds
Cardio Mode of Choice	1 – 3 minutes	TBD	0 – 60 seconds
Dumbbell Squat	10 – 18	TBD	0 – 60 seconds
Cardio Mode of Choice	1 – 3 minutes	TBD	0 – 60 seconds
Dumbbell Squat	10 - 18	TBD	0 – 60 seconds

CONTINUED

Plyometric Supersets

Alternate a traditional strength exercise with a plyometric exercise.

CONTINUED

Example

Photo By: Lance Cpl. Jackeline M. Perez Rivera

CONTINUED

Sample Plyometric Superset Workout

Exercise	Reps	Sets	Resistance	Rest Between Sets
Back Squat	**15**	**2 – 4**	**TBD**	**30 – 60 seconds**
Jump Squat	10	2 - 4	Bodyweight Only	30 – 60 seconds
Back Squat	**15**	**2 - 4**	**TBD**	**30 – 60 seconds**
Jump Squat	10	2 - 4	Bodyweight Only	30 – 60 seconds
Back Squat	**15**	**2 - 4**	**TBD**	**30 – 60 seconds**
Jump Squat	10	2 - 4	Bodyweight Only	30 – 60 seconds

CONTINUED

Combined Training

- Combined training is doing cardiovascular and resistance training within the same session.
- It is arguably the most effective training method for weight loss and general fitness.

CONTINUED

Key Difference

- Cardiovascular and strength exercises are not done as supersets or circuits as described earlier but in succession.
- For example, 20 minutes of jog-walk intervals on the treadmill followed by 20 minutes of total body strength training.

CONTINUED

Example

CONTINUED

Complex Training

- Advanced form of strength and conditioning that pairs two biomechanically similar lifts.
- What differentiates complex training from other training methods is that one exercise is a moderate to heavy weight conditioning lift (moderate to high intensity) while the other exercise is a plyometric drill.

CONTINUED

Conditioning Lifts

- Squat.
- Deadlift.
- Bench Press.
- Any Olympic or all-body power lift.

CONTINUED

Explosive Lifts

- Cycled split jumps.
- Depth and/or plyometric push-ups.
- Smith machine explosive press.
- Jump squats.

Photo By: Lance Cpl. Jackeline M. Perez Rivera

CONTINUED

Outcome

Designed to improve:

- Muscle strength.
- Muscle power.

CONTINUED

Complex Training Programming

Example of a complex training set –

- One set of back squats (conditioning lift) paired with a set of tuck jumps (plyometric drill).
- Repeated three to four times.

CONTINUED

Example

CONTINUED

Complex Training Programming

Because complex training is advanced and uses heavy lifts and plyometric drills it should be reserved for intermediate to advanced level fitness clients and athletes.

*Must have mastered exercise mechanics.

CONTINUED

Establishing Strength Readiness

For **lower-body strength**, the athlete should be able to squat 1.5 times his or her body weight.

For **upper-body strength**,

1. Athletes that weigh more than 220 pounds need to be able to bench press their body weight.
2. Athletes that weigh less than 220 pounds need to be able to bench press at least 1.5 times their body weight or perform 5 clap push-ups in a row.

CONTINUED

Establishing Speed Readiness

1. For **lower-body** speed, exercisers should be able to complete 5 repetitions of the back squat at 60% or more of his or her body weight in 5 seconds or less.
2. For **upper-body** speed, exercisers should be able to complete 5 repetitions of the bench press at 60% or more of his or her body weight in 5 seconds or less.

CONTINUED

Choosing Resistance

Follow these two general rules to determine the weight of the medicine ball:

1. The ball must be heavy enough to slow the exercise but not so heavy to reduce the range of motion.
2. The ball must NOT be so heavy that it makes it difficult for the client to comfortably control the ball for at least **5 repetitions**.

CONTINUED

Upper Body Plyometrics

Lower body plyometric drills require strength and balance and produce a lot of impact forces. For those reasons, they may not be a good place to start, but a compromise is to use low-intensity upper body plyometric exercises like:

1. Kneeling ball pass.
2. Medicine ball chest pass training.

CONTINUED

Lower Body Plyometrics

Once lower body strength has been developed, readiness has been established, and balance is not an issue, start with a small range of motion:

1. Jump squat.
2. Jump and reach drills.

CONTINUED

Sample Routine

Exercise	Sets	Reps	Between-set rest break
Medicine ball chest pass alternated with dumbbell chest press or fly.	3	10 - 18	30 seconds to two minutes

CONTINUED

Progression

A simple progression strategy is:

after two weeks, add a 4th set of 10 - 18 repetitions.

CONTINUED

Training Load

CONTINUED

Defined

Training load is the cumulative effect of training frequency, volume, and intensity.

*Includes time in competition.

CONTINUED

External Training Load

- Measures the amount of work done during training and competition.
- Quantified by analyzing training mode, frequency, number of sets and repetitions, and intensity.
- External training loads are indicators of muscle strength, power, speed, and acceleration and are measured by specific tests of muscle capacity.

CONTINUED

Internal Training Load

- Describes how the body responds to the external training load.
- Includes things like heart rate, blood lactate levels, oxygen consumption, and rate of perceived exertion (RPE).
- Varies day to day and over time.

CONTINUED

Overtraining

CONTINUED

What happens…

- Breaks down the body's natural defenses **over time**. Chronic event.
- Affects mind and body.
- It is counterproductive.
- It can be dangerous and lead to injury and even death.

CONTINUED

Symptoms of Overtraining

- Fatigue.
- Depression.
- Loss of motivation.
- Loss of interest.
- Anxiety.
- Increased blood pressure.
- Increased heart rate.
- Illness
- Increased rate of injury.
- Chronic muscle soreness.
- Joint pain.
- Delayed Recovery.
- Poor sleep.
- Insomnia.
- Decreased ability to concentrate.

CONTINUED

Solution

- The only solution is rest.
- Rest required for full recovery can vary from days to months, and depends on severity of overtraining and symptoms.

Rhabdomyolysis

Defined

Rhabdomyolysis is characterized by the breakdown of muscle tissue that causes the release of muscle fiber contents into the blood.

Overtraining Difference

- It is an acute event.
- Easily avoidable.

Who is at Risk?

- People new to exercise.
- Detrained and deconditioned persons.
- Trained persons under excessive exercise conditions.

CONTINUED

Training Example

100 repetitions of lunges followed by…

100 push-ups and….

100 squats, repeated.

CONTINUED

Too much or too hard?

Rhabdomyolysis is more likely to be a result of too much volume versus intensity.

CONTINUED

Rest Periods

CONTINUED

Rest

- Is an active programming variable.
- It takes on many forms including:
  - Within sets (seconds to minutes).
  - Between sets (seconds to minutes).
  - Hours.
  - Days.
- It can be both active and relatively passive.
- It is the mechanism of recovery and muscle growth and performance gains.

CONTINUED

Programming Rest

1. 24-hour cycles.
2. Intermittent rest.
3. Rest while training includes:
   1. Inter-set (between sets) rest periods.
   2. Intra-set (within sets) rest periods.
4. Lower and upper rest limits.

CONTINUED

Why 24-hours?

- All of your body's systems are on 24-hour cycles.
- Governed by the master clock in the brain.
- Muscles are also on 24-hour cycles governed by their own internal muscle clocks and the master clock.

What is a Muscle Clock?

Muscle Clocks

- Internal clocks inside each of your over 600 skeletal muscles.
- Made up of proteins.
- Regulate muscle action according to:
  1. Environmental changes.
  2. Exercise training and programming.

"Muscle clocks keep time for your muscles, telling them what to expect and when. They let your muscles know when to expect to train versus rest and recover."

~ Dr. Amy

How do Muscle Clocks Work?

CONTINUED

How Muscle Clocks Work

- They keep track of 24-hour cycles.
- They monitor specific cues they get from your environment and your body throughout the day to optimize muscle performance.

CONTINUED

Cues

- Light–night
- Hormone levels
  - Testosterone
  - HGH
  - Cortisol
- Activity–rest patterns
- Eating habits
- Muscle pliability
- Exercise programming
  - type of training
  - timing of training

"Muscles use cues to learn to anticipate what happens when, like resistance training, and in response turn on the molecular events associated with muscle performance outcomes ahead of scheduled training. This maximizes outcomes like size, strength, and power development."

~ Dr. Amy

How Muscle Clocks Communicate

- Myokines are released from muscles during exercise or muscle contraction.
- Myokines relay cues about the timing of exercise, allowing muscles and other structures to anticipate upcoming workout sessions and improve muscle performance.

Time of Day of Training

- Goal dependent.
- Type of training dependent.
- Lifestyle dependent.
- Consistency is the key.

Using Internal Clocks to Program

CONTINUED

Time of Day Recommendations

- Cardiovascular in the mid morning.
- Sport specific or mind-body work midday.
- Strength and power training 4 – 6 pm.

CONTINUED

Cues

CONTINUED

Testosterone

- Levels naturally fluctuate throughout the day.
  - Highest in the morning – around 8 am.
  - Begin to level off between 4 and 6 pm, decreasing after that.

CONTINUED

Muscle Pliability

Muscles are most pliable around 4 pm to 6 pm.

CONTINUED

Intermittent Rest

CONTINUED

Intermittent Rest

Rest two days per week on non-consecutive days to stay on a 24-hour cycle (Ashmore, 2019).

CONTINUED

Sample Routine

Day	Time	Resistance Training
Monday	4 pm	Resistance Training
Tuesday	REST	REST
Wednesday	4 pm	Resistance Training
Thursday	REST	REST
Friday	4 pm	Resistance Training
Saturday	REST	REST
Sunday	4 pm	Resistance Training

CONTINUED

Research

CONTINUED

Rest Within Sessions

The 1st aspect of timing we addressed was overall scheduling (24-hours and IR). The 2nd aspect of timing to address is **rest while training**.

- Between set (inter-set) rests.
- Within set (intra-set) rests.

CONTINUED

Question #1

Do rest intervals within sets yield greater muscle strength and power improvements than two minute traditional between-set rest periods (Oliver, 2013)?

CONTINUED

Rationale

- With minimal rest during a set, the goal is to coax the muscle to produce greater force within a shorter time period.
- Intra-set rests provide the muscle with minimal recovery within a set.
- This should result in greater strength and power improvements.

*Note: it should also allow for greater focus on mechanics and full ROM.

CONTINUED

Methods

- Cluster set group did 8 sets of 5 repetitions each with 60 seconds rest between each set of 5.
- Traditional set group did 4 sets of 10 with two minute rests between each set of 10.

CONTINUED

Measurements

1RM on the bench press were measured along with power output (60% one repetition maximum)

- before the study began.
- after four weeks.
- at eight weeks.
- at 12 weeks.

CONTINUED

Conclusion

60-second intra-set rest breaks resulted in statistically significant greater strength gains and power output in the bench press than traditional two-minute between set rest breaks.

*Indicating that for upper body strength gains, intra-set rest periods were more effective.

CONTINUED

Block Training Cluster Set

Exercise	Repetitions	Sets	Resistance	Intra-set Rest Periods
Strength Exercise	5	8	80% or above of 1RM	60 seconds
Strength Exercise	5	8	80% or above of 1RM	60 seconds

CONTINUED

Question #2

How effective is **Redistributed Rest Training (RRT)** for strength development versus cluster sets which are similar to traditional set training (Tufano, 2017)?

CONTINUED

With-in Set Rest Breaks

- Cluster Set: 2 – 4 – 6 reps for example and then rest.
- Redistributed Rest Training (RRT): equal rest between each rep.

CONTINUED

Methods

The three different training groups:

- Group #1: Athletes did four cluster sets (CS4) that included 30 seconds of rest after the 4th, 8th, 16th, 20th, 28th, and 32nd exercise repetition in addition to 120 seconds of rest after the 12th and 24th repetitions.

CONTINUED

Methods

- Group #2: For these athletes, the total 420 seconds of rest given to the CS4 group was redistributed to include nine sets of four repetitions each with 52.5 seconds of rest after every fourth repetition (RR4).
- Group #3: The final group used a unique protocol where the total 420 seconds of rest was evenly distributed after each of the 36 single repetitions resulting in 12 seconds of rest after each repetition (RR1).

CONTINUED

Results

#1: **Peak muscle force was maintained during redistributed rest over each repetition** (RR1), but was less for cluster and RR4 for subsequent repetitions.

#2: With redistributed rest over each repetition (RR1) mean and peak muscle velocity along with **mean and peak muscle power remained the same**; however, they all decreased every four repetitions during cluster and RR4 training.

Conclusion

These data indicate that when total rest time is redistributed over each repetition, the kinetics and kinematics of each exercise repetition is more constant improving muscle strength and power performance results.

Definitions

- Kinetics: rate of change in movement. Velocity.
- Kinematics: joint motion like flexion/extension, etc. Mechanics.

continued

Sample Workout: RRT

Exercise	Reps	Resistance	Intra-set rest breaks after each repetition
Modified Romanian Deadlift	Up to 36	80% or above of 1RM	10 - 60 seconds
Back squat	Up to 36	80% or above of 1 RM	10 - 60 seconds

continued

Rest Lower and Upper Limits.

CONTINUED

Lower Limit

Muscles need to rest for **at least 48 hours** after high-intensity exercise (greater than 85% maximum capacity) to return to baseline strength levels.

CONTINUED

Upper Limit

Length of recovery periods should not exceed **96 hours**. After 96 hours detraining occurs.

CONTINUED

HIT Strength Programming

CONTINUED

Strength Training Programming

- Bilateral or unilateral exercises.
- Upper or lower body exercises.
- Agonist-antagonist exercises.

CONTINUED

Routine for Bilateral Lower-Body Exercises

Exercise	Reps	Resistance	Between-set rest break
Back squat	6-10	65-85% 1RM	30 seconds-4 minutes
Seated knee extension	6-10	65-85% 1RM	30 seconds-4 minutes
Back squat	6-10	65-85% 1RM	30 seconds-4 minutes
Seated knee extension	6-10	65-85% 1RM	30 seconds-4 minutes
Back squat	6-10	65-85% 1RM	30 seconds-4 minutes
Seated knee extension	6-10	65-85% 1RM	30 seconds-4 minutes

CONTINUED

Routine for Lower-Body Exercises With Upper-Body Exercises

Exercise	Reps	Resistance	Between-set rest break
Back squat	6-10	65-85% 1RM	30 seconds-4 minutes
Lateral dumbbell raise	6-10	65-85% 1RM	30 seconds-4 minutes
Back squat	6-10	65-85% 1RM	30 seconds-4 minutes
Lateral dumbbell raise	6-10	65-85% 1RM	30 seconds-4 minutes
Back squat	6-10	65-85% 1RM	30 seconds-4 minutes
Lateral dumbbell raise	6-10	65-85% 1RM	30 seconds-4 minutes

Routine for Agonist–Antagonist Exercises

Exercise	Reps	Resistance	Between-set rest break
Hip abduction	6-10	65-85% 1RM	30 seconds-1 minute
Hip adduction	6-10	65-85% 1RM	30 seconds-1 minute
Hip abduction	6-10	65-85% 1RM	30 seconds-1 minute
Hip adduction	6-10	65-85% 1RM	30 seconds-1 minute
Hip abduction	6-10	65-85% 1RM	30 seconds-1 minute
Hip adduction	6-10	65-85% 1RM	30 seconds-1 minute

Paired Training Method

CONTINUED

Paired Training Method

- Uses biomechanically-similar paired exercises.
- Two exercises:
  - Similar or same joint action.
  - Similar or same muscle action.

(Ashmore, 2019)

CONTINUED

Why?

Play on volume –

- Because one of the biggest dilemmas facing athletics is overtraining.
- Pairing biomechanically similar exercises allows us to stress maximally the target muscles while varying mechanics enough to change how we work muscles.

CONTINUED

Paired Routine for Upper Body Exercises

Exercise	Reps	Resistance	Between sets rest breaks
Bench Press	4 - 6	65 – 85% of 1RM	30 seconds up to four minutes
Push-up	4 – 6	Body weight	30 seconds up to four minutes
Bench Press	4 - 6	65 – 85% of 1RM	30 seconds up to four minutes
Push-up	4 – 6	Body weight	30 seconds up to four minutes
Bench Press	4 - 6	65 – 85% of 1RM	30 seconds up to four minutes
Push-up	4 – 6	Body weight	30 seconds up to four minutes

CONTINUED

Mixed-intensity Solution

CONTINUED

Mixed-intensity training

Vary the loads (intensity) used during a session and even during a set.

CONTINUED

The Study

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https://www.ncbi.nlm.nih.gov/pubmed/28532248

CONTINUED

Methods

Three different training load groups:

- Three high-intensity (80% 1RM) sets.
- Three low-intensity (30% 1RM) sets.
- A single high-load set (80%) with an additional drop set without recovery progressively reducing weight to 30% 1 RM (mixed-intensity training) – this is the mixed-intensity set.

CONTINUED

Volume

It is important to note that the training volume was about 2/3rds of the three set high and low-intensity in the mixed-intensity set.

*Mixed-intensity set – which was 80% initially with a drop-set was lower volume training.

Conclusion

Lower volume mixed-intensity training can simultaneously increase muscle hypertrophy, strength, and endurance when compared to traditional three set high-intensity or low-intensity training models.

Running's Dilemma

CONTINUED

"Strength gains are negatively impacted by high-intensity cardiovascular training."

Doma and Deakin, 2013; Jones et al 2017

CONTINUED

Cardiovascular Programming for Strength

Mode

- Cycling is recommended.
- Running/jogging decreases strength more than cycling.

Duration

Limit cardiovascular endurance training sessions where strength gains are the primary training goal to 20 – 30 minutes max.

CONTINUED

Frequency

- Schedule cardiovascular endurance and strength training on alternate days.
- Limit cardiovascular endurance training to three or fewer times per week.

CONTINUED

Intensity

- Direct relationship between intensity of cardiovascular endurance exercise and strength decrements.
- For best results, low to moderate cardiovascular endurance work is recommended.

Sample Cardiovascular Workout

Day	Exercise mode	Intensity	Duration
Monday	Off		
Tuesday	Cycling	40-75%	20-30 minutes
Wednesday	Off		
Thursday	Cycling	40-75%	20-30 minutes
Friday	Off		
Saturday	Cycling	40-75%	20-30 minutes
Sunday	Off		

Wrap-up

CONTINUED

Key message

- HIT is an effective way to train for most persons when sound programming is used.
- Sound programming includes a careful consideration for rest during training and after.

CONTINUED

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continued

Thank you!
~ Dr. Amy