Chapter 16: Training for Sport

REHSCI 1215 Exercise Physiology

Training for Sport - Outline

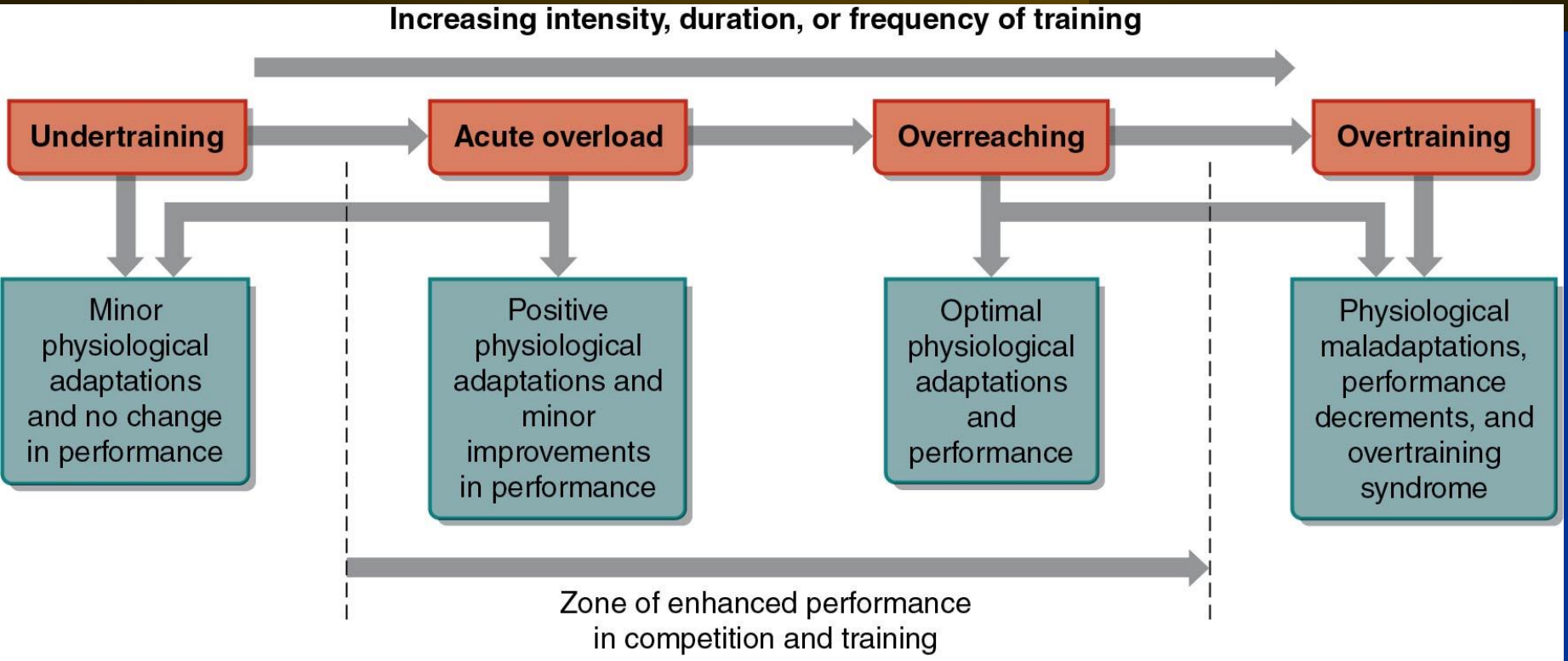
- Optimization training
- Periodization of training
- Overtraining
- Tapering for peak performance
- Detraining

Training for Sport: Introduction

- Positive stress: improvements in performance
  - Major training adaptations in 6-10 weeks
  - Rate of adaptation genetically limited

- Balance of volume & intensity
  - Must include rest
  - Correct balance enhances performance

Fig. 16.1. Model of Continuum of Training Stages



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General Adaptation Syndrome (GAS)

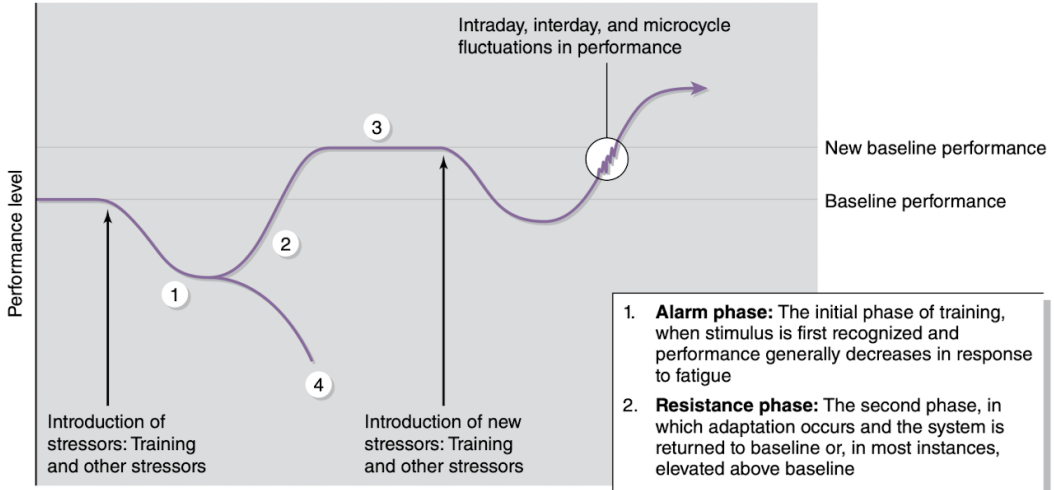


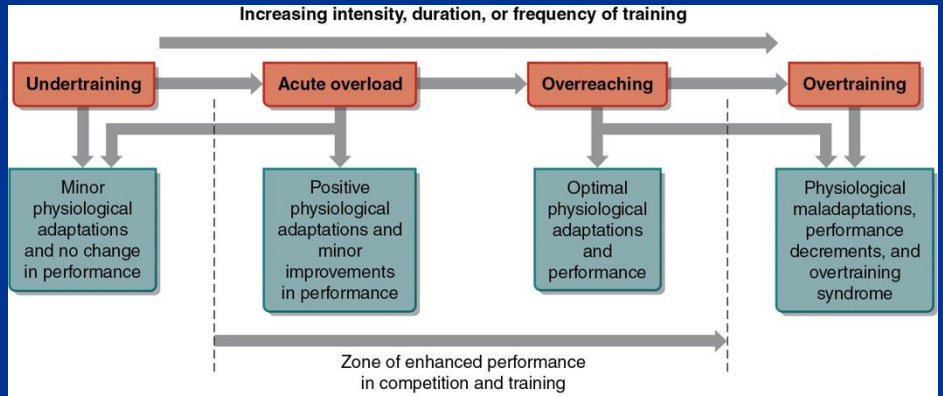
FIGURE 21.1 The General Adaptation Syndrome (GAS) and application to periodization.

Adapted, by permission, from Haff and Haff, 2012 (28).

Overreaching

Systematic attempt to overstress body for *short* period

- Allows body to adapt to stronger stimulus
- Caution: easy to cross into overtraining



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Functional vs. Nonfunctional Overreaching

Functional Overreaching

- Short-term decrements in performance
- Takes days or weeks to recover
- It can be a planned stressor during programming to elicit a ”super-compensation”

Nonfunctional Overreaching

- Decrements in performance for weeks to months
- Characterized by decreased performance, increased fatigue, decreased vigor, and hormonal disturbances

Overreaching Continuum

TABLE 5.3 Theoretical Development of Anaerobic Overtraining

Stages of overtraining	Day(s)	Anaerobic performance							
		Performance	Neural	Skeletal muscle	Metabolic	Cardiovas-cular	Immune	Endocrine	Psycholog-ical
Acute fatigue	Day(s)	No effect or **increase**	Altered neuron function	—	—	—	—	—	—
Functional overreaching (FOR)	Days to weeks	**Temporary** decrease, returns to baseline	Altered motor unit recruitment	—	—	—	—	Altered sympathetic activity and hypotha-lamic control	—
Nonfunc-tional overreaching (NFOR)	Weeks to months	**Stagnation** or decrease	Decreased motor coor-dination	Altered excitation–contraction coupling	Decreased muscle glycogen	Increased resting heart rate and blood pres-sure	Altered immune function	Altered hormonal concentra-tions	Mood distur-bances
Overtraining syndrome (OTS)	Many months to years	**Decrease**	—	Decreased force production	Decreased glycolytic capacity	—	Sickness and infection	—	Emotional and sleep distur-bances

Reprinted, by permission, from Fry et al., 1993 (62); Meeusen et al., 2013 (140).

Overtraining

Unexplained ↓ in performance & function for weeks, months, or years

- Can't be remedied by short-term ↓ training, rest, or proper diet
- May have psychological & physiological causes
- Can occur with all forms of training: resistance, anaerobic, aerobic

Overtraining Syndrome

- Highly individualized, subjective
- Necessary to rule out other causes
- Symptoms-physiological & psychological
  - ↓ strength, coordination, capacity
  - Fatigue
  - Change in appetite; weight loss
  - Sleep and mood disturbances
  - Lack of motivation, vigor, or concentration
  - Depression

Excessive Training

- Training above what's needed for peak performance
  - Doesn't meet criteria for overreaching or overtraining

- Volume and/or intensity increased beyond optimal level
  - For years, many athletes undertrained
  - As intensity or volume ↑, so did performance

More is better is NOT true after a point

Exercise Addiction

- Threatens overall health
- Distinguished by continuing to exercise despite:
  - Injury
  - Inconvenience
  - Disruption
  - Lack of time

Overtraining Syndrome: Treatment and Prevention

Treatment

- Reduced intensity or complete rest
- Rest (weeks, months)
- Counseling to deal with stress

Prevention

- Periodization training
- Adequate caloric intake

Periodization of Training

- Allows for varied training load
  - Enables acute overload & overreaching without overtraining
- Divided into cycles-multiyear to micro cycles (a few days)
- Best for athletes who focus on one competition
- Includes general exercises and specific exercises to stimulate motor skills

Types of Periodization

Linear (Traditional) Periodization

- linear progression of Intensity and linear reduction in volume

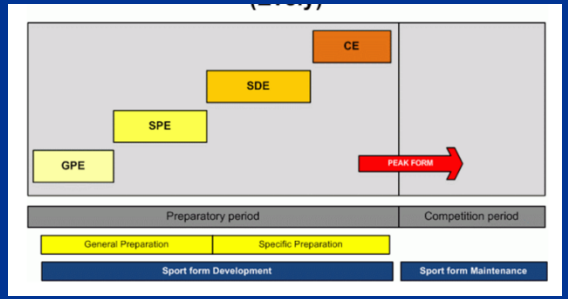
Undulating/Non-Linear Periodization

- Weekly or Daily
- Different training goals every week or training day
- Undulating volume and load

Block Periodization

- Similar to linear periodization
- Different “blocks” focus on specific training goals (hypertrophy, Strength, Power)

Block



Linear (Traditional)

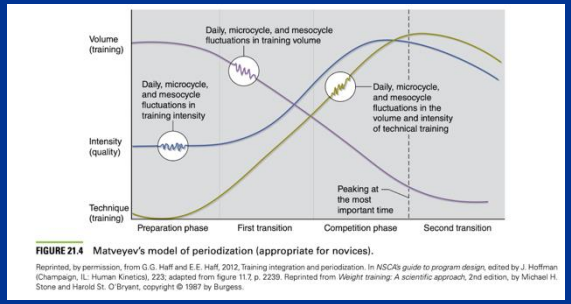
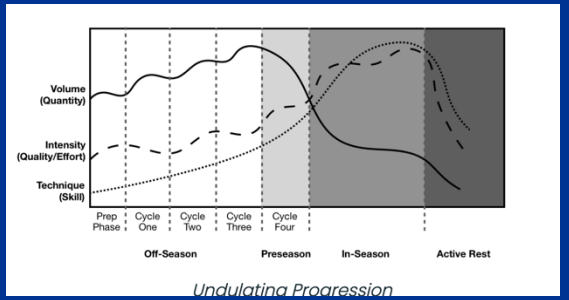


FIGURE 21.4 Matveyev's model of periodization (appropriate for novices).

Reprinted, by permission, from G.G. Haff and E.E. Haff, 2012, Training integration and periodization. In *NSCA's guide to program design*, edited by J. Hoffman (Champaign, IL: Human Kinetics), 223; adapted from figure 11.7, p. 2239. Reprinted from *Weight training: A scientific approach*, 2nd edition, by Michael H. Stone and Harold St. O'Bryant, copyright © 1987 by Burgess.

Undulating



Undulating Progression

Periodization Terminology

TABLE 21.1 Periodization Cycles

Period	Duration	Description
Multiyear plan	2-4 years	A 4-year training plan is termed a quadrennial plan.
Annual training plan	1 year	The overall training plan can contain single or multiple macrocycles. Is subdivided into various periods of training including preparatory, competitive, and transition periods.
Macrocycle	Several months to a year	Some authors refer to this as an annual plan. Is divided into preparatory, competitive, and transition periods of training.
Mesocycle	2-6 weeks	Medium-sized training cycle, sometimes referred to as a block of training. The most common duration is 4 weeks. Consists of microcycles that are linked together.
Microcycle	Several days to 2 weeks	Small-sized training cycle; can range from several days to 2 weeks in duration; the most common duration is 1 week (7 days). Composed of multiple workouts.
Training day	1 day	One training day that can include multiple training sessions is designed in the context of the particular microcycle it is in.
Training session	Several hours	Generally consists of several hours of training. If the workout includes >30 min of rest between bouts of training, it would comprise multiple sessions.

Adapted, by permission, from G.G. Haff and E.E. Haff, 2012, Training integration and periodization. In *NSCA guide to program design*, edited by J. Hoffman (Champaign, IL: Human Kinetics), 220.

Linear Periodization

- Model of periodization developed by Leo Matveyev (“godfather” of periodization)
- Popular model for novice to intermediate athletes
- follows a “linear” structure of developing size, strength, and power.
- Can be applied to both Resistance and Endurance training
- General rule of thumb: As training season progresses, training intensity increases while volume decreases

Linear Periodization: Phases of Training

Preparatory:

- Aim is hypertrophy, strength endurance, and basic strength
- Very low sport specificity training
- Low-intensity, high-volume

First Transition

- Aim is strength and power
- More sport-specific training
- Low- very high intensity, low-volume

Competition

- Aim is Peaking and Maintenance
- Most Sport Specific training
- High-moderate intensity, very low volume

Second transition

- Active rest
- Period of no sport and little to no resistance training
- Usually involves recreational activities not characteristic of sport

TABLE 21.2 A Periodization Model for Resistance Training

Period	Preparatory		First transition	Competition			Second transition
Subperiod	General preparatory	Specific preparatory	Precompetitive	Main competitive			Postcompetitive
Season	Off-season	Preseason		In-season			Postseason
Phase	Hypertrophy/ strength endurance	Basic strength	Strength/power	Peaking	Or	Maintenance	Active rest
Intensity	Low to moderate	High	Low to very high	Very high to very low		Moderate to high	Recreational activities (may not involve resistance training)
	50-75% of 1RM	80-95% of 1RM	87-95% of 1RM*	50% to ≥93% of 1RM		85-93% of 1RM	
			30-85% of 1RM**				
Volume	High	Moderate to high	Low	Very low		Low to moderate	
	3-6 sets***	2-6 sets***	2-5 sets***	1-3 sets***		~2-5 sets***	
	8-20 repetitions	2-6 repetitions	2-5 repetitions	1-3 repetitions		3-6 repetitions	

*These percentages of 1RM apply to nonpower core exercises.

**These percentages of 1RM apply to power exercises. The actual percentage used to elicit power development depends on the exercise that is used. For more information see Kawamori and Haff (39).

***These recommendations do not include warm-up sets and represent only target sets for core exercises (2); they also do not include lower-intensity recovery days that are often part of a periodized training plan (27).

Adapted from 27, 56, 57, 58, 59.

Tapering for Peak Performance

- Tapering involves reducing training volume or intensity
  - Before major competition
    - Recovery/healing
  - 4-28+ days

- Results?
  - Increased muscular strength
    - Muscles repaired
    - Glycogen reserves replenished

Tapering for Peak Performance

- Does *not* result in deconditioning
  - Possible to reduce training volume & maintain $\dot{V}O_{2max}$

- Leads to improved performance

Taper Benefits

TABLE 8.7 Summary of performance gains following a taper. Adapted from the review of Wilson and Wilson (2008)

- 5–6% improvements in criterion competition performance gains.
- Up to 20% increases in neuromuscular function (i.e., strength and power).
- 10–25% increases in cross sectional area of muscle tissue.
- 1–9% improvements in VO_2max (this is likely a consequence of hypervolemia, up to a 15% increase in RBC production and increases oxidative enzyme activity).
- Up to an 8% increase in running economy.
- Serum TST may increase by 5%, with a corresponding 5% decrease in cortisol.
- Catecholamines may be reduced by up to 20%.
- Reduced creatine kinase concentrations (suggestive of decreased muscle damage following a workout).

Tapering Strategies

- Linear Taper
- Step Taper
- Exponential Taper

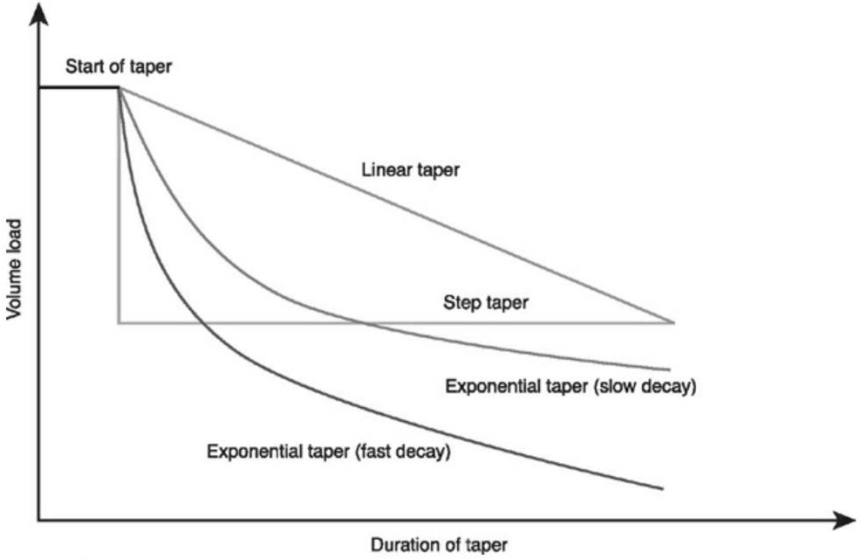


FIGURE 8.12 Schematic representation of the three principle tapering strategies. Adapted from Mujika and Padilla (2003).

Basic Steps for Creating A Resistance Training Program

- Needs Analysis
- Exercise Selection
- Training Frequency
- Exercise Order
- Training Load (Volume and Intensity)

Example of Needs Analysis and its application

Scenario A
Female collegiate basketball player
Preseason

SPORT EVALUATION

Movement analysis

Sport: Running and jumping, ball handling, shooting, blocking, and rebounding

Muscular involvement: All major muscle areas, especially the hips, thighs, and shoulders

Physiological analysis (primary requirement)

Strength/power

ATHLETE'S PROFILE

Training background

- Has resistance trained regularly since high school
- Possesses excellent skill in performing free weight and machine exercises
- Just completed a 4×/week resistance training program in the off-season consisting of

  Upper body exercises (2×/week): 6 exercises (2 core, 4 assistance), 3 sets of 10RM-12RM loads

  Lower body exercises (2×/week): 6 exercises (2 core, 4 assistance), 3 sets of 10RM-12RM loads

CLASSIFICATION OF RESISTANCE TRAINING STATUS

Advanced

PRIMARY PRESEASON RESISTANCE TRAINING GOAL

Strength/power[a]

Scenario A
Female collegiate basketball player
Preseason

CORE

Hang clean (all body, power)[a]
Snatch and clean (all body, power)[a]
Push press (all body, power)[a]
Front squat (hip and thigh)
Incline bench press (chest)
Pull-up (back, shoulders, arms)

ASSISTANCE

Abdominal crunch (abdomen)
Seated row (upper back)
Stiff-leg deadlift (posterior hip and thigh
Standing calf raise (posterior lower leg)

COMMENTS

[a]These exercises are included to maximize power and match the jumping movements of basketball.

Periodization Activity

- Pick a sport of interest (Basketball, Powerlifting, Soccer, Cross Country)
- Research your sport and complete a mini needs analysis for the sport (primary energy systems utilized, movement patterns, training age)
- Develop a Resistance training session that you would include within a mesocycle for each training phase in the linear periodization model (Preparatory, first transition, competition, second transition)
  - Be sure to include sets and reps along with intensity (%1RM)
  - Limit your training session to include 4-5 exercises
- After you complete each session of training (should be 4 in total), explain why you included these exercises in this phase and how they are relevant to your sport (i.e. relate it to your needs analysis)

Click Here for Exercises you can include in your program:

In-season Periodization Example

Detraining

- Loss of training-induced adaptations
  - Partial or complete
  - Due to training reduction or cessation
- Brief period = tapering
- Longer period = detraining

Detraining- Strength & Power

- Immobilization
  - Immediate loss of muscle mass, strength, power
- Training cessation
  - Variation in rate of strength and power loss
- Causes?
  - Atrophy (immobilization)
  - Reduced ability to recruit muscle fibers
  - Altered rates of protein synthesis versus degradation
- Loss mitigated by low-level exercise
  - Type??? Isometric! Why??

Detraining-Endurance

- Muscle endurance ↓ quickly
  - Change after 2 weeks of inactivity
  - ? from muscle or cardiovascular changes
  - Changes in oxidative enzyme activity

Detraining

- Muscle glycogen stores ↓
- Acid-base balance disturbed

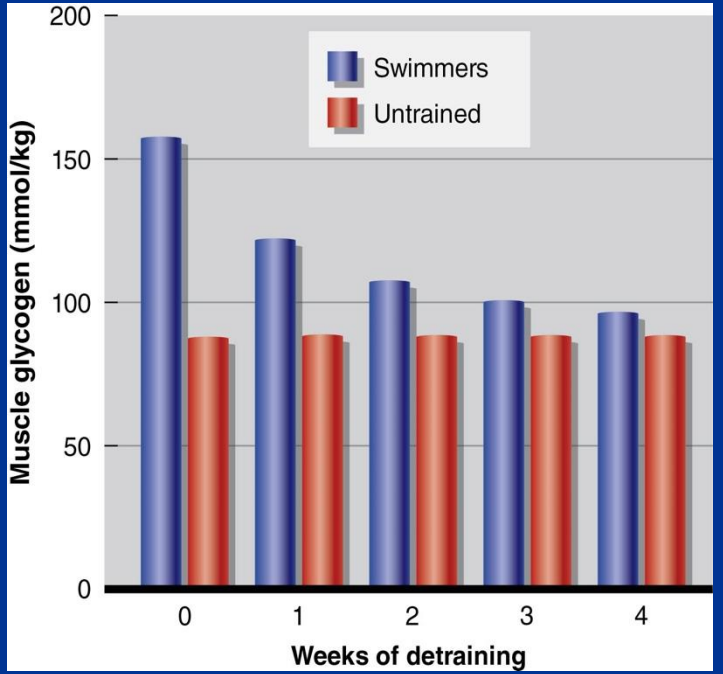


Figure 16.10 Changes in glycogen content of deltoid in swimmers during 4 weeks of detraining

Detraining: Speed, Agility, & Flexibility

Training → only moderate ↑ speed, agility

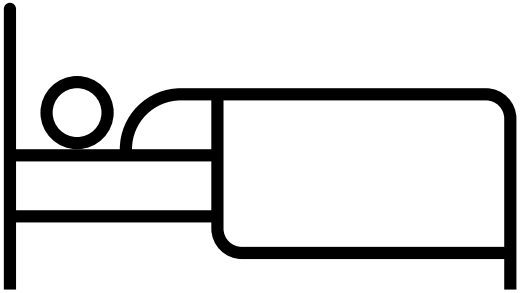
Detraining → only moderate ↓ speed, agility

Form, skill, flexibility are also lost.

Sprint performance still suffers.

Detraining- Cardiorespiratory Endurance

- Significant cardiorespiratory losses with 20 days of bedrest
  - Significant ↑ submaximal HR
  - 25% ↓ submaximal stroke volume
    - due to ↓ plasma volume
  - 25% ↓ maximal cardiac output
  - 27% ↓ $\dot{V}O_{2max}$



How to prevent losses in physical conditioning?

- How much activity is needed?
  - Losses occur when frequency and duration decrease by 2/3 of regular training load
  - 70% $\dot{V}O_{2max}$ training is sufficient to maintain maximal aerobic capacity

Training intensity is important!

Detraining in Space

- Microgravity exposure = detraining
  - Normal gravity challenges heart & muscles
  - Detraining may be *beneficial* in space
- Muscle mass and strength ↓
  - Particularly postural muscles
  - Type I, II fiber cross-sectional area ↓
  - Without muscle stress, bone loss

Detraining in Space

- Stroke volume ↑
  - Less hydrostatic pressure, no blood pooling in lower extremities
  - More venous return
- Total blood volume ↓
  - Plasma volume ↓ due to ↓ fluid intake, ↑ capillary filtration
  - Red blood cell mass ↓
  - In space → beneficial adaptation
  - On earth → orthostatic hypotension

Detraining in Space

- $\dot{V}O_{2max}$ ↓ immediately postflight
  - Due to ↓ plasma volume and leg strength
  - Preflight, in-flight $\dot{V}O_{2max}$ data unknown
- With bed rest, $\dot{V}O_{2max}$ ↓
  - ↓ total blood volume
  - ↓ plasma volume and maximal stroke volume
- In-flight exercise essential to preserve astronauts' long-term health

Summary

Overreaching

- Performance is maximized by varying training periods of undertraining, acute overload, & overreaching.
- If used properly, overreaching is an important element in a training program because it promotes maximal physiological & metabolic adaptations.

Excessive training

- Unnecessarily high training volume & intensity provide no added performance benefits & increase risk of impaired performance.

Overtraining syndrome

- Overtraining syndrome is complex and involves psychological factors, such as excessive expectations, competitive stress, social and family involvement, personal and emotional problems, training monotony, and extra-sport demand from work or school.
- Predicting the overtraining syndrome - The symptoms of overtraining vary, and diagnosis is difficult, but heart rate response to a fixed-pace exercise bout may be predictive.

Tapering for peak performance

- Optimal taper duration can be 4-28+ days, depending on athlete and sport.
- Less training is required for maintaining gains in fitness & strength than for attaining them.

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