Advanced Resistance Training for Health and Performance

Intelligent Fitness™

Dear Student

Welcome to Advanced Resistance Training for Health and Performance.

For many years resistance training was an area of conditioning that lacked serious scientific investigation. Consequently, many myths and misunderstandings have arisen that lead to poor programme design and ineffective and potentially dangerous training techniques.

Fortunately, there is now a growing body of scientific evidence relating to all areas of resistance training. The purpose of this three day module is to dispel many of the popular myths, discuss the relevant scientific evidence and allow mastery of the necessary practical skills.

On completion of this module exercise professionals will be confident in the assessment of muscular strength and endurance and the design of appropriate programmes for customers with a range of clinical conditions as well as those with more athletic goals.

This module has been written to provide you with a reference source and to add structure to your study; which is essential if you are to gain a thorough understanding of the subject.

This module may be used on its own. However, the best results will be achieved by also attending any corresponding Intelligent Fitness training days.

I trust you will find this module worthwhile.

David Wells

Principal Intelligent Fitness Trainer

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Muscular Endurance

Muscular endurance is the ability to sustain repeated muscle actions or to sustain isometric contractions for an extended period of time.

A number of different types of muscular endurance have been identified including:

- Power endurance
- Short duration endurance
- Medium duration endurance
- Long duration endurance
- Speed endurance

Power endurance

Power endurance is the ability to perform power-dominated movements repeatedly, such as throwing punches throughout a boxing match or repeatedly jumping throughout a basketball game.

Muscular endurance of short duration

Muscular endurance of short duration refers to the muscular endurance necessary for events ranging in duration from 40 seconds to 2 minutes, such as swimming a 100m or running 400m.

Muscular endurance of medium duration

Muscular endurance of medium duration refers to the endurance required for activities 2 - 5 minutes in duration such as middle distance running (800m - 1500m), martial arts and 200m and 400m swimming.

Muscular endurance of long duration

Muscular endurance of long duration refers to the ability to apply force against a standard resistance for periods of longer than 6 minutes, such as road cycling, distance running and 800m swimming.

Speed endurance

Speed endurance refers to the ability to maintain or repeat high velocity actions numerous times in a set period of time, such as those that occur in football, rugby and basketball.

Estimating 1RM from Muscular Endurance Tests

There is evidence to suggest that a strong relationship exists between muscle endurance (measured as the number of repetitions to failure) and 1RM.

Therefore muscular strength (1RM) can be predicted with a fair degree of accuracy from muscular endurance tests.

Ball and Rose (1991)
Braith et al (1993)
Invergo et al (1993)
Kurmato and Payne (1995)
Mayhew et al (1992)
all cited by Heyward (2006)

Estimates of 1RM of younger individuals (22 – 36 years) can be made from the muscular endurance bench press test (to be discussed later in text).

Calculation

Information Required	
Gender	Male or Female
Number or repetitions completed during the bench press muscular endurance test	Reps

Female: Predicted 1RM = (0.31 x bench press repetitions) + 19.2

r: 0.87 and SEE = 3.2kg

Male: Predicted 1RM = (1.55 x bench press repetitions) + 37.9

r: 0.87 and SEE = 8.0kg

Mayhew and Peterson (2002)
cited by Heyward (2006)

For Example

Gender	Female
Number of repetitions completed during the bench press muscular endurance test.	30

Predicted 1RM = (0.31 x 30) + 19.2

Predicted 1RM = 9.3 + 19.2

Predicted 1RM = 28.5kg

Six Basic Laws of Strength Training

Bompa and Carrea suggest six basic laws of strength training that should be applied to ensure optimal adaptation whilst avoiding injury. These are:

1. Develop flexibility
2. Develop ligament and tendon strength
3. Develop core strength
4. Develop the stabilisers
5. Train movements not individual muscles
6. Focus on what is necessary, not what is fashionable

1. Develop flexibility

The safe and effective performance of most resistance training exercises requires a certain amount of flexibility, especially around the knees, ankles, hips and shoulders.

Assessment of an individual's posture / flexibility and the prescription of a relevant stretching programme should be undertaken before initiating a strength programme.

A detailed discussion of postural and muscle length assessment and appropriate strategies to address faults and common problems is discussed collectively in the Intelligent Fitness modules 'Postural Assessment and Correction' and 'Flexibility: The Art and Science of Stretching'.

2. Develop ligament and tendon strength

A sufficient period of anatomical adaptation (see periodisation) should be included in the programme design to ensure that not only the muscles, but also the connective tissues (tendons and ligaments) are strengthened prior to more demanding training being undertaken.

3. Develop core strength

Core muscles acts as shock absorbers during jumping; stabilise the spine; and serve as a link between the arms and legs. Weak core muscles cannot perform these roles effectively, which in turn will limit an individual's performance.

It is important to remember that the arms and legs are 'only as strong as the trunk'.

Repetition Tempo (The Contraction Velocity Spectrum)

The speed at which each repetition is performed is referred to as the repetition tempo or the contraction velocity spectrum.

This is an important variable within a programme that needs to be manipulated to determine specific training outcomes such as improvements in power, strength, hypertrophy and muscular endurance.

With regard to training for particular functional activities, the specificity principle must be applied to the speed of contraction, as functional movements occur at different velocities; thus the exercise professional must prescribe the appropriate speed of movement to obtain optimum results.

The speed of muscle contraction is greatly influenced by the resistance to be lifted (the force velocity curve). That is, force production is inversely related to velocity of muscle shortening during concentric actions, ie. during faster movements less force production is possible, and when lifting heavier loads slower movements take place.

The accepted tempos for each training effect

Training Adaptation	Tempo (eccentric/isometric/concentric)	
Speed and Power	As fast as Possible	(1/1/1)
Strength	Moderate Speed	(3/1/1)
Hypertrophy	Slow Speed	(4/2/2)
Endurance	Slow-Moderate	(3/2/1)

Clarke and Corn (2001)

The recognised shorthand format for describing repetition tempos is to write the time (in seconds) for the three phases in the following order: eccentric, isometric, concentric.

Bompa and Carrera suggest it is often difficult for individuals to focus on the precise timing of a repetition whilst concentrating on the other aspects of exercise performance.

Exercise professionals should schedule the speed of repetitions as either fast, moderate, or slow but manipulate concentric and particularly eccentric repetition speed when attempting to maximise muscle fatigue and growth of lean muscle mass.

The ACSM Guidelines

The ACSM suggest that for the average participant training for health related strength and endurance, the movements should be rhythmic and performed at a moderate repetition tempo of approximately 3 seconds concentric, 3 seconds eccentric.

ACSM (2006)

Tempos for Strength

When training for maximal strength Bompa and Carrera suggest the lifter performs an explosive concentric lift, followed by a 2 second pause before slowly (3 – 4 seconds eccentric) lowering the bar. (3 to 4/2/1)

They further suggest that in order to optimise concentric strength, the lifter should remove any reflexive or elastic qualities that may be produced in the eccentric phase by pausing for 2 seconds before the next concentric phase.

This technique should only be used when training for maximal strength and when trying to break a strength plateau.

Bompa and Carrera (2005)

Tempos for Power

It is important to note that when training for maximum strength and power, the intended speed should be as fast as possible to ensure the recruitment of the fast twitch fibres, as only a high speed of contraction against a maximum load will rapidly recruit the fast-twitch fibres and result in increased maximum power.

When an individual is lifting a heavy load (eg. 90% 1RM), the movement may appear to be slow due to the force velocity curve, but actually the force against the resistance is being applied as fast as possible.

Tempos for Hypertrophy

Manipulating lifting speed can also be beneficial when hypertrophy is the goal. The main premise for careful manipulation of lifting speed or time under tension is that the greater the time the muscle fibres are contracted, the greater the protein breakdown, thus the higher the level of adaptation and muscle growth.

The concept of time under tension has in recent years gained greater recognition. Simply explained, the amount of time a muscle is contracted produces specific adaptations.

For Example

The optimum time under tension for hypertrophy is considered to be 20 – 70 seconds.

This equates to 8 – 10 repetitions at a tempo of either of 2/2/1 or 4/2/2

Super-Slow Training

Super-slow training, a method developed by Ken Hutchins in 1982, has caused considerable debate and controversy amongst strength and conditioning experts. It requires the lifter to perform a 10 second concentric phase followed by a 4 second eccentric phase.

The reputed claims of super-slow

It is hypothesised that super-slow training achieves superior strength gains in comparison to more conventional lifting speeds, as slower speed movements require greater muscle tension and permit higher force output than faster movements.

It is important to note that due to the reduced role of momentum, weight loads must initially be reduced by 10 – g133

20% to allow correct exercise form. However, as the lifter becomes accustomed to the slower speed, the load increases as does muscle strength.

Westcott suggests that although excellent results have been gained with 6 – 10 weeks of super-slow training, longer periods may require high levels of motivation and/or supervision by an exercise professional, as the super-slow protocol is much more difficult to perform.

Wescott (2004)

Bompa and Carrera's Periodisation Model for Sports

Bompa and Carrera suggest a model of periodisation that subdivides the three main phases of training (preparatory, competitive and transition) into 6 cycles:

- Anatomical adaptation
- Hypertrophy
- Maximum strength
- Conversion
- Competitive
- Transition

Bompa and Carrera (2005)

This further division of the three main phases of training within Bompa and Carrera's periodisation model provides the exercise professional with a comprehensive and structured framework that is easily adapted to meet each individual's training requirements.

Anatomical Adaptation Phase

The purpose of the anatomical adaptation phase is to prepare the muscles, ligaments, tendons, and joints to endure the subsequent more demanding phases of training.

If vigorous strength training is initiated without this prepartory training, the muscles strengthen before the ligaments and tendons have done so, thus increasing the risk of injury.

The majority of muscle groups are targeted during this phase, not just those specific to the sport or activity, with considerable emphasis being placed upon the musculature of the core and the stabilisers of the body.

It is during this phase that any muscle imbalances and postural problems are addressed as emphasis is placed upon balanced development.

The duration of the anatomical adaptation (AA) phase is dependent upon:

- The length of the preparatory phase
- The individual's background in resistance training
- The importance of strength in the given sport

A guide to AA duration for novice and experienced exercisers

Individual	Duration of anatomical adaptation phase	Goal of training phase
Inexperienced individuals	8 – 10 weeks	As the goal of AA training is to involve most, if not all of the muscle groups in a multilateral programme, a high number (9 – 12) of exercises are required
Experienced individuals with 4 – 6 years of training	approximately 4 weeks	

Training parameters for the anatomical adaptation phase

Training parameters	Novice individuals	Experienced individuals
Duration of AA	8 – 10 weeks	3 – 5 weeks
Load if weights are used	30 – 40 % of max	40 – 60% of max
No. of stations per circuit	9 – 12	6 – 9
No. of circuits per session	2 – 3	3 – 5
Total time of circuit session	20 – 25 minutes	30 – 40 minutes
Rest interval between exercises	90 seconds	60 seconds
Rest interval between circuits	2 – 3 minutes	1 – 2 minutes
Frequency per week	2 – 3	3 – 4

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