# WEIGHT TRAINING TECHNIQUES

to maximise your sports performance

A SPECIAL REPORT FROM

PEAK PERFORMANCE

The research newsletter on stamina, strength and fitness

# WEIGHT TRAINING TECHNIQUES

to maximise your sports performance

# WEIGHT TRAINING TECHNIQUES

## to maximise your sports performance



A CIP catalogue record for this book is available from the British Library.

Printed by: Peach Print Limited
Impressions House, 3-7 Mowlem Street, London E2 9HE

Published by P2P Publishing Ltd

Registered office: 33-41 Dallington, London, EC1V 0BB
Tel: 0845 450 6402 Registered number: 06014651

ISBN: 978-1-905096-75-6

**Publisher** Jonathan A. Pye
**Editor** John Shepherd
**Designer** Magdalena Wielopolska

# OTHER TITLES IN THE PEAK PERFORMANCE SPECIAL REPORT SERIES

**ACHILLES TENDINITIS** – PREVENTION AND TREATMENT
**CARBO LOADING** – FOR THAT EXTRA EDGE
**COACHING YOUNG ATHLETES**
**CREATINE** – CUTTING THROUGH THE MYTHS
**DYNAMIC STRENGTH TRAINING FOR SWIMMERS**
**TRAINING FOR MASTER ATHLETES**
**FEMALE ATHLETES** – TRAINING FOR SUCCESS
**SHOULDER INJURIES** – PREVENTION AND TREATMENT
**MARATHON TRAINING** – FOR YOUR PERSONAL BEST
**NUTRITIONAL SUPPLEMENTS** – BOOSTING YOUR PERFORMANCE
**SPORTS PSYCHOLOGY** – THE WILL TO WIN
**TRAINING FOR SPEED, POWER & STRENGTH**
**ALL WEATHER TRAINING** – BEATING THE ELEMENTS
**BODY FUEL** – FOOD FOR SPORT
**TRAINING FOR ENDURANCE**
**FOOTBALL PERFORMANCE** – HOW TO RAISE YOUR GAME
**TRAINING FOR RUGBY**
**TRAINING FOR CYCLING**
**RESISTANCE TRAINING** – THE NEXT LEVEL
**CORE STABILITY** – INJURY FREE PERFORMANCE
**TRAINING FOR ROWING**
**SPORTS PSYCHOLOGY II** – THINK YOUR WAY TO SUCCESS
**ANTIOXIDANTS** – TRAIN LONGER, TRAIN HARDER
**TRAINING FOR TRIATHLON**
**FOOTBALL PERFORMANCE II** – NEW GOALS FOR SUCCESS
**TRAINING FOR DISTANCE RUNNING**
**KNEE PAIN** – PREVENTION AND TREATMENT
**HYDRATION** – FOR OPTIMAL SPORTS PERFORMANCE
**TRAINING FOR TENNIS**
**RUNNING INJURIES** – PREVENTION AND TREATMENT

**The above reports are available at a cost of £29.99 each from Peak Performance (S/R), 33-41 Dallington Street, London, EC1V 0BB. Cheques should be made payable to Peak Performance.**

# CONTENTS

# Introduction

Nearly all athletes weight-train – rowers, runners, footballers and even crown green bowlers (for the Manchester Commonwealth Games). However, doing the 'right' weight training for your sport is crucial, as the 'wrong' training could actually slow you down. In this PP special we look specifically at how to get the most from weight training for sport in order to achieve peak performance.

The first five chapters deal with more general issues that influence the efficacy of a weights programme for sports performance. Chapter 1 addresses the 'hidden' consequences of weight training, ie hormone release. Knowing what these are and what they can do in terms of training effect sets the scene for the next four chapters. These deal with how to maximise your strength (chapter 2), how to use weight training to boost power (chapter 3), the importance of recovery (chapter 4) and whether it is possible for weight training and training for endurance to take place at the same time (chapter 5).

We then move on to more specific chapters that look at exercises and training programmes. Chapters 6 and 7 explain the relevance of Olympic lifts and their variants to sport-specific training. Despite their detractors, BJ Rule presents a very strong case for their inclusion in the training routines of most athletes. Key technical tips are also provided. Tommy Matthews then gives us a little history lesson in chapter 8 in his consideration of one of the great 'new/old' weight training tools, the kettlebell. And in chapter 9 Tommy outlines a specific weight-training programme (using Olympic lifts, kettlebell and other weight training exercises) for rugby.

After digesting this PP special you will be in a far stronger (pun intended) more informed position to fully understand what weight training can do to boost your sports performance or that of those you coach.

## Contributors

John Shepherd is an ex-international athlete and coach to internationals. He is Peak Performance Premium editor and has written hundreds of articles and 10 books on sports training.

BJ Rule is a sports and fitness trainer and strength and conditioning coach based in London. He holds a BSc in exercise science and owns and runs a trainer education company, Optimal Life Fitness, teaching trainers how to train clients in the use of kettlebells, Olympic weightlifting and boxing. He also runs the One Personal Training Studio in London. BJ has played a wide range of sports, including rugby league (semi-professionally), football and triathlon, and has had an amateur boxing bout. He now trains using Olympic lifting, kettlebell sport and boxing methods.

Tommy Matthews is a managing director of Optimal Life Fitness limited and a specialist fitness and sports training instructor.

# The hidden effects of weight training

**Athletes weight-train to improve performance, because everything else being equal, a weight-trained muscle is more resilient and better able to generate force. There are numerous weight-training systems on offer to coaches and athletes, and their effects on promoting a specific fitness response are relatively well known. However, the same cannot be said of the effects of different weight-training systems on the endocrine system and hormone levels. As John Shepherd explains, these weight training-induced hormonal changes have significant effects on muscle trainability and performance, and are also related to age, sex and workout intensity.**

## Hormones, the endocrine system and weight training

Physiologists refer to hormones as 'chemical messengers'. They are produced by the **endocrine system** and endocrine glands, such as the hypothalamus in the brain and the gonads. The major function of hormones is to change the rates of specific reactions in specific target cells. The cell's actual response to a hormone is determined by the presence of certain protein receptors in its membrane or in its interior. Muscle fibres, like the rest of the body, are constituted from cells and the way a hormone interacts with these can significantly affect training adaptation. The hormonal contribution involves a complex physiological response, but ultimately this results in the **DNA**-mediated synthesis of new contractile proteins, which are vital to muscle cell function and integrity.

**Growth hormone (GH)** – GH is released from the anterior pituitary gland in the brain soon after exercise commences;

however, the precise effects of this GH release seem to be a function of the age of the exerciser (of which more later). GH is often regarded as the 'sport hormone' because it is involved in numerous anabolic functions relating to cell proliferation and division throughout the body. Specifically, GH stimulates bone, cartilage and muscle growth and can play a very significant role in lean muscle mass and fat deterioration/accumulation. This explains why it has been used as an illegal ergogenic aid. GH release via exercise is also augmented by a further chemical reaction. Basically, hormones that would otherwise act to blunt GH production (eg somatostatin) are suppressed by the production of other chemicals produced during exercise (endogenous opiates). In short, GH's ergogenic training-induced effect can contribute toward creating a leaner, stronger, more powerful athlete.

**Testosterone –** Testosterone is produced in men through the testes and in women (though to a much lesser extent) via the ovaries. The primary role of testosterone is to augment the release of GH and to interact with the nervous system. To clarify the latter, hormones can influence mood and behaviour. An increased level of testosterone could, for example, result in greater feelings of aggressiveness/dominance through 'interpretation' by the nervous system and brain. The mechanisms behind this process (and other hormonal influences on behaviour) are complex.

**Cortisol –** Cortisol is released from the adrenal gland and its levels are also elevated by exercise. Cortisol stimulates protein breakdown, leading to the creation of energy in the form of glucose in the liver. This is not good for those looking to build muscle, as amino acids (released via dietary protein breakdown) become preferentially used for energy production rather than muscle building.

It should be noted that high hormone levels can affect cellular response negatively as well as positively. For example, too great a hormonal stimulus can desensitise cells, reducing

## Jargonbuster

**1 repetition maximum (1RM)**
This is the maximum amount of weight you could lift on one attempt.

**Spike**
Spike simply means 'to boost'. It indicates that a sudden, specific reaction has been achieved by a certain stimuli.

**Body mass index (BMI)**
BMI is used to determine a person's 'healthy' weight. It provides a strong indication of fat versus non-fat body weight. BMI uses a mathematical formula that accounts for a person's height and weight. BMI equals a person's weight in kilograms divided by their height in met.

their ability to positively adapt (this is known as 'down regulation'), and should be borne in mind, especially when considering cortisol.

**Weight training intensity, GH and muscle building**

Research by scientists from the University of Connecticut examined the hormonal responses and adaptation to resistance exercise and training[1]. They noted that high-volume, moderate- to high-intensity weight training, using short rest intervals and stressing a large muscle mass, tended to produce the greatest acute hormonal elevations (notably testosterone and GH). In comparison low-volume, high-intensity resistance training methods using long rest intervals did not induce a similarly high hormonal response.

Charles Van Commenee (the coach of Olympic heptathlon gold medallist Denise Lewis and now head of UK Athletic's coaching team) advocated the use of weight training sessions with heavy weights, in excess of 90% of 1 repetition maximum (1RM), in numerous sets (8+), using full recoveries. This was in stark contrast to the usual 70-80% of 1RM workouts, employing 6 to 8 fast movement repetitions over 3 to 6 sets – a staple workout for the sprinter- or jumper-type athlete.

Van Commenee's reasoning was that the latter type of workout was more of a body-builder's one – ie it was designed to produce an increased anabolic hormonal (notably, GH-producing) workout response which would build more muscle (reasoning confirmed by the study above). He believed that the key relevance for the athlete is 'power-to-weight ratio'. According to Van Commenee, a higher-intensity, greater GH-releasing workout might increase an athlete's weight sufficiently to compromise performance. However, the heavier, low-repetition workout, although it developed crucial athletic power, was less likely to do so.

The author is aware that the triple-jumper Jonathan Edwards regularly used these high-weight, low-repetition weight workouts. The world record-holder and Olympic champion was very light (he weighed in at 65kg at his peak), yet extremely powerful.

**Jargonbuster**

**DNA**
(Deoxyriboncleic acid) is the blueprint of every living organism. Specifically, it's a highly specialised series of molecules (nucleic acids) that are found in the nuclei of all cells. DNA is transmitted across generations, through reproduction. It can be 'read' and its code used for various genetic and forensic purposes.

Sometimes, an athlete may wish to increase his or her lean muscle mass in order to enhance sports performance – rugby players and power athletes such as shot putters may do this, for example – and then high-intensity 'power' (androgen-stimulating) workouts are entirely appropriate. The key point is that when planning a weight training schedule, coach and athlete should not only just take into account the perceived benefits of the session per se on muscle fibre power output, but also the hormonal effects it can have on influencing the former's weight.

## Age, sex and hormone release

Is weight training-mediated GH release affected by the age and sex of the athlete? Scientists from the University of North Carolina noted that GH secretion did vary in relation to age and sex(3). They discovered that the magnitude of GH release was greater in young women than in young men, and perhaps less surprisingly, was reduced four- to sevenfold in older individuals compared to their younger counterparts. It seems that the late teens and early 20s appear to be a good time to boost lean muscle mass in female athletes, as their bodies appear more responsive to hormonally stimulated, weight training-induced muscle growth.

## Age and GH secretion

The researchers also noted that the age-related drop in GH secretion was often associated with deleterious health effects, although a cause-and-effect relationship was not established. The good news is that while exercise interventions may not restore GH secretion to the levels observed in the young, exercise is still a robust stimulus for GH secretion. The implications of this for the master athlete are relatively obvious; ie where possible, intense weight training should be performed to naturally spike GH levels. This will contribute toward maintaining lean muscle mass, which declines significantly with age (see later for suggested weight-training workouts and their hormonal responses).

## Testosterone, age, sex and weight training

Research by Finnish scientists examined the relationship between age and sex and weight training-induced testosterone release[4]. Forty-two subjects were divided into 4 groups:

1. 10 middle-aged men (average age 42).
2. 11 middle-aged women (average age 39).
3. 11 elderly men (average age 72).
4. 10 elderly women (average age 67).

The study consisted of 6 months of heavy resistance training and explosive exercises. It was discovered that functional training response was improved significantly; 1RM values increased in the middle-aged men by 27%, in the elderly men by 16%, in the middle-aged women by 28% and in the elderly women by 24%. Training stimulated a significant testosterone response in both male groups, but not in the female groups. GH levels, on the other hand, increased in all groups, except the oldest women. In terms of providing an explanation for the latter, the researchers noted that, 'The physiological significance of the lack of acute responsiveness of GH to heavy resistance exercise in older women… during prolonged strength training requires further examination.' It is possible that the specific hormonal effects of the menopause on women's body chemistry make positive weight training-stimulated androgen release much less of a likelihood for them. However, overall these findings demonstrate again the value of weight training for a positive hormonal response in the older athlete.

Similar results were obtained by further research from Kraemer and team, who examined the effects of heavy resistance training on the hormonal response patterns of younger (average age 32) and older (average age 62) men(5). Their research is worth noting for its findings on the cortisol response in older men. Using four sets of 10 repetition squats with 90 seconds of rest between sets, the researchers found that squat strength and thigh-muscle cross-sectional area increased for both groups.

Hormonally the younger men demonstrated higher testosterone levels than the older men, both at rest and in response to exercise. However, with training, the older group demonstrated a significant increase in testosterone in response to exercise stress. They also experienced a significant decrease in resting cortisol. This overall response is ideal for increasing lean muscle mass; testosterone helps spike GH production and lower cortisol levels favour protein use for muscle building rather than supplying energy or breaking down muscle tissue.

## Response of elite athletes

Finally, some interesting Italian research looked at much more highly trained subjects and studied the GH response induced by the total training programme (ie weights, track work and so on) of elite Italian track and field athletes(5). Ninety-nine Italian elite athletes from different disciplines (61 male, 38 female, aged 17 to 47) volunteered to participate in the investigation.

The scientists discovered that basal GH concentrations were significantly higher in females (6.2ng/ml) compared to males (1.9ng/ml). These were negatively correlated with age and **body mass index (BMI)** – ie higher age and BMI predicted lower basal GH levels. GH levels were also found to be significantly higher in females than in males performing the same discipline, in agreement with the North Carolina study above[(3)].

However, when post-exercise total GH output was measured, these gender-related differences disappeared. Simply put, the men's GH levels caught the female's over time. This can be explained by the fact that males have greater resting concentrations of GH compared to females. Thus, when comparing the sexes, what the females gained in terms of exercise-induced GH response, the males made up for with resting concentrations.

It was also discovered, in keeping with the consistent findings of exercise induced GH response, that higher-intensity workouts increased GH response. This theme is considered in detail in chapter four, 'Weight training and recovery'.

## Summary

Weight training (and exercise in general) has both outward and inward training effects. As coach or athlete you may tend to think only of the former, ie the production of greater power-producing muscles. However, the design of a weight-training programme can have significant hormonal effects, which in turn can significantly affect the amount of lean muscle gains. This can then affect power-to-weight ratio and be either negative or positive on sport performance, depending on the specifics of the activity.

## Weight Training, Selected Sports And Hormonal Response: Suggested Workouts

*All these programmes target the elevation of increased GH and each workout should consist of exercises that recruit large muscle*

| Target group | Workout aim | Suggested workout |
|---|---|---|
| Young women aged in late teens/ early 20s who are long/triple/ high-jumpers or basketball/ volleyball/tennis players | To promote powerful lean muscle | 4x8 fast @80%1RM – slightly incomplete recovery |
| Men (sports as above) | To promote powerful lean muscle | 4x8 fast @80%1RM slightly incomplete recovery |
| Men/women (sports as above) | To promote power/ strength without building too much muscle | 10x1 @95% 1RM – full recovery (5-6min between reps) |
| Master athletes – male (sports as above) | To promote muscle maintenance and power | 1) 4x8 fast @75%1RM – full recovery |
| Master athletes – female (sports as above) | To promote muscle maintenance and power | 2) 4x2 @90 1RM* |
| Master athletes – endurance sports | Primary purpose to promote muscle maintenance | 1) 4x10 fast @70%1RM, slightly incomplete recovery** |

*groups, ie squats for the legs; chest, back and shoulders for upper body.*

**Due to the natural age-related decline in master athlete's muscle mass, it is appropriate to also include these heavier workouts, to maximise muscle maintenance, power and strength gains.*
***Endurance training reduces muscle mass, as muscle protein is used for fuel and the high calorific output keep weights down. The older endurance athlete needs to combat both training and age related declines, hence the reason for this workout.*

## References:

*1) Sports Med. 35(4):339-61, 2005*
*2) Sports Med. 32(15):987-1004, 2002*
*3) J Gerontol A Biol Sci Med Sci. Feb; 55(2):B95-105, 2000*
*4) J Endocrinol Invest. Feb; 27(2):121-9, 2004*
*5) J Endocrinol Invest. 2004 Feb;27(2):121-9.*

## Jargonbuster

**Endocrine system**
The endocrine system deals with chemical communication produced by hormones. The system influences the body in a multitude of ways, ranging from metabolism to growth to mood. As previously mentioned, the endocrine system works hand in hand with the nervous system.

# Going for maximum strength: it's not all about lifting as heavy weights as possible – or is it?

**In this article John Shepherd takes a look at research and training theory from a number of sports, including Olympic weightlifting, body building and more 'everyday' fitness weight training, in order to determine the best ways to train for maximum strength.**

## Maximum strength versus bulk

Maximum strength is often equated with big muscles. To a degree this is true, as bigger muscles can exert more force than smaller ones. However, athletes with the biggest muscles are not necessarily the strongest in terms of maximum lift ability, ie a body builder may not be as strong as an Olympic or power lifter, despite having larger muscles. Power-to-weight ratio can also be vitally important (see chapter one).

To gain strength (and/or size) the **weight training system employed** must have a significant **anabolic** output. This will stimulate increased muscle growth through the release of **growth hormone** and **testosterone** (see chapter one). These workouts also need to target **fast twitch muscle fibre.**

### Intensity rules?

A team of researchers from Finland investigated hormonal and neuromuscular responses and recovery in strength athletes versus non-athletes during heavy resistance exercise[1]. Eight

### Jargonbuster

**Weight training system -** references the myriad ways of combining weight lifted (loading) with repetitions, set numbers, exercise order and speed of lift.

**Anabolic –** hormonal response resulting in an increase in physiological functioning.

**Fast twitch muscle fibre –** power and size producing muscle fibre (also known as Type II or white muscle fibre).

**Growth hormone –** key anabolic hormone, levels elevated by exercise.

strength-trained athletes and eight physically active but inexperienced athletes participated in the study. The 16 participants performed the 'forced' (FM) and 'maximum' (MR) repetitions training protocol – both intense training systems. The MR protocol included 12 repetition maximum (12RM) squats for four sets with two minutes' recovery between sets. In the FR protocol the initial load was higher than in MR so that the subject could lift approximately eight repetitions on their own plus four with assistance.

The loading protocols blood samples were taken before and after to determine testosterone, **cortisol** and growth hormone concentrations and **blood lactate**. The researchers measured maximal voluntary **isometric** force and **EMG** activity of the leg extensors before and after the workouts and 24 and 48 hours later. The concentrations of the hormones measured increased significantly after both protocols. However, the responses tended to be higher in the FR group, compared to the MR group. It was argued that this would indicate a greater potential for strength increase, due to the increased anabolic response.

In terms of weight-training experience it was discovered that testosterone concentrations were significantly higher for both the FM and MR protocols in the strength-trained athletes. This could be attributed to the fact that these athletes were better able physically and, crucially, mentally, at recruiting more of their muscle fibre. This led the researchers to conclude that, 'at least in experienced strength athletes, the forced-repetition protocol is a viable alternative to the more traditional maximum-repetition protocol and may even be a superior approach.' So going 'beyond the last rep/reps' seems to offer greater maximum strength gain potential. However, it is important to note that this does not mean that the athlete will be more powerful (ie overcome resistance as fast as possible), which is an important consideration for specific conditioning – of which more later.

## Lactate release and intensity

Body builders believe that higher levels of lactate stimulate a

## Strength types

There are different types of 'strength types', of which maximum strength is one. Table 1 provides an overview of the way these 'strength types' are developed using weights.

### Table 1: Different strength types and how to train for them

| Strength type | Primary purpose | Most commonly used weight training system | Common sports applications |
|---|---|---|---|
| Strength endurance | To develop muscles' ability to produce repeated contractions under conditions of fatigue | High reps (15-plus) with light loadings (30-50% 1RM) | Field sports, rowing, martial arts |
| Power | To enable fast and powerful movements to be produced | Medium number of reps (six to 10) with medium to heavy loadings (70-80% 1RM) | Sprints, long jump, football, javelin, shot |
| Maximum strength | To enable maximum loads to be lifted | Low numbers of reps (one to five) with heavy loading (80-100% 1RM) | Power lifting, Olympic lifting, shot put |
| Size with strength | To increase muscle size | Medium to high numbers of reps (eight to 12) with medium to heavy loading (70-80%-plus 1RM) | Body building or sports such as American football, where increased size is a valuable asset |

**Note:** some sports require all strength types to one degree or another and the weight training programme should reflect this.
1RM references one repetition maximum – the maximum amount of weight achievable on one lift

### Jargonbuster

**Testosterone –** male sex hormone (found also in women) – an anabolic hormone elevated after exercise.

**Cortisol –** released from the adrenal gland, its levels are also elevated by exercise. Stimulates protein breakdown, leading to the creation of energy in the form of glucose from the liver. This is contrary to the needs of an athlete looking to increase muscular strength and size, as amino acids (released via dietary protein breakdown) become preferentially used for energy production, rather than muscle building.

greater anabolic response. A current body building system currently in vogue involves 10 x 10 repetitions with 2 minutes' recovery between sets, using an 80% 1RM weight. These workouts target different body parts over four sessions a week, using a split routine methodology. During the workout the first four sets are performed as quickly as possible, whilst adhering to correct form. This workout is particularly interesting as it combines medium to heavy weight training with 100 repetitions per body part which would – if the loadings were lighter – develop strength endurance. However, this workout is designed to produce strength with bulk - hence my addition to the traditional strength types in table 1, 'size with strength'. This workout is incredibly tough. High levels of lactate will be produced in muscles; this indicates a high glycolysis rate (the burning of carbohydrate in muscles), which in turn provides a greater muscle stimulus. This should mean increased potential for post workout strength gains due to the amount of muscle fibre recruitment, muscle protein breakdown and re-synthesis and the magnitude of the crucial anabolic hormonal release.

Indian researchers looked at the lactate responses of five Olympic weight lifters across their different lifts, the clean and jerk and the snatch and different weight training systems, across three workout types[2].

1) One repetition lift (ORL).

For this workout the Olympic lifters lifted 30, 40, 50 and 60kg once with an interval of five minutes between lifts.

2) Multiple-set session (MSS).

3) One-set session (OSS).

Both the MSS and OSS consisted of six sets of lifts at 50% 1RM x 6; 60% 1RM x 5; 70% 1RM x 4; 80% 1RM x 3; 90% 1RM x 2; and 100% 1RM x 1. In MSS, three to 3.5 minutes' recovery was allowed between successive sets, whereas for OSS the interval was approximately 24 hours between the 'one sets'.

Not surprisingly, from what has been presented so far, lactate levels were very low in the ORL condition. In the MSS, lactate reached a peak at an intermediate set (when reps were still relatively high and load relatively heavy). For the OSS workout it was maximum after the first set and then declined gradually (ie the set with the most reps produced the highest lactate concentrations on the first day).

What about the actual lifts? Lactate levels were significantly higher for the clean and jerk as opposed to the snatch. This led the researchers to conclude that, '… (a) anaerobic glycolysis is not stimulated considerably when the lifting time is only 4-5 seconds, (b) repetition of lift plays a more important role than intensity in lactate production, (c) CJ is more strenuous than SN for a given %RM.'

These findings further vindicate the conclusion that higher numbers of repetitions produce the greatest potential for maximum strength gains due to the anabolic response – this time linked to lactate production. It is becoming apparent that the heaviest lifting does not necessarily produce the best physiological conditions for maximum strength gain.

Continuing with the intensity theme, a team of researches from the Spanish Olympic Committee looked at the effects of three intensities of weight training(3). The team used the the snatch, clean and jerk and squat lifts as their measures, with 1RM being the determining factor. Twenty-nine trained junior weightlifters were randomly assigned to one of three groups:
1) low-intensity group (LIG)
2) moderate-intensity group (MIG)
3) high-intensity group (HIG).

All subjects trained for 10 weeks, four to five days a week and followed a **periodised** training routine using the same exercises and training volume (expressed as total number of repetitions performed at intensities equal to or greater than 60% of 1RM). However, there were different numbers of repetitions at intensities of 90-100% of 1RM for the three groups over the 10-week period. These were 46 repetitions for the LIG group, 93 for the MIG group and 184 for the HIG group. The key findings relevant to the subject matter of this article were that:
1) the MIG and LIGs displayed a significant increase for clean

## Jargonbuster

**Blood lactate –** body chemical used to fuel muscular activity. It is elevated in response to exercise, although it is present in the body at all times.

**Isometric –** muscular contraction than involves no movement i.e. pressing against a door frame.

**EMG –** measurement of electrical activity in a muscle. The more there is, the greater the amount of muscle fibre recruitment.

**Catabolic –** a negative training situation created by overtraining and tough training phases, resulting in a reduction in muscle size – see also cortisol (chapter 1).

**Jargonbuster**

**Split routine –** weight-training system that trains one body part/ muscle group (eg legs) during one workout and another (eg arms) in another.

**Periodised –** training plan that systematically and progressively builds fitness.

and jerk (10.5% and 3% for MIG and LIG, respectively) and squat (9.5% and 5.3% for MIG and LIG, respectively)
2) the increase in strength for the HIG increase occurred only in the squat (6.9%).

This led the researchers to conclude that over the 10-week period the MIG protocol in particular produced the greatest enhancements in weightlifting performance, compared with low and high volumes of weight training in experienced, trained young weightlifters. So, similarly to the previous research, we have another vindication for the statement that medium-intensity loadings optimally stimulate muscle fibre. In these scenarios the weights are heavy enough to hit fast twitch fibres, yet light enough to be moved relatively quickly, which seems to be the way to generate a highly desirable and optimum anabolic response. The HIG's performance could have been mitigated

## More thoughts on rest between sets

Rest has already been identified as a crucial factor in influencing the strength outcomes of weight-training workouts. A review of relevant research indicated that shorter recoveries between sets seemed to be best for muscle-size increases[5]. Again, this was attributed to the release of greater concentrations of the anabolic hormones. In terms of maximum strength one to two minutes was seen to be adequate. However, other researchers have discovered that strength increases are very specifically correlated to the reduction of rest between sets, ie the shorter the rest period, the greater the strength gains. A team from Australia discovered that sets with virtually no recovery between them (just a matter of seconds) produced superior strength gains to sets with a couple of minutes' rest between them, for the bench press (9.7% to 4.9% respectively)[6]. Interestingly, there were no differences in power outputs among the survey's junior elite, football and basketball players, as measured by bench throws, between either training protocols. So we have a further conundrum in the weight-training, strength-boosting stakes – the same workout having different effects. This is very important for coach and athlete to dwell on. If maximum strength is the desired outcome, then less rest seems to be the significant factor in a workout. If power is more desirable – as it is for the majority of sports – then greater rest should be taken between sets.

### The importance of varying repetitions at percentages of 1RM in relation to the weight's exercise being performed

Very often athletes and their coaches perform and plan sessions that use the same number of repetitions across all exercises, for example 3 x 8 repetitions at 75% 1RM on squat, bench press, clean and lunge. A team of researchers from Connecticut set out to discover whether doing this was indeed the most effective way of increasing strength[4]. Their study involved trained (T) and untrained (UT) men. Specifically, they wanted to determine the maximal number of repetitions that the two groups could perform doing free weight exercises at various percentages of 1RM. Eight T and 8 UT men were tested for 1RM strength; they then performed one set to failure at 60, 80, and 90% of 1RM in the back squat, bench press and arm curl. The team discovered that more back squat repetitions were able to be performed than bench press or arm curls at 60%, 80 and 90%1RM for T and UT (although this was less pronounced at the higher levels). No differences in number of repetitions performed at a given exercise intensity were noted between T and UT (except during bench press at 90% 1RM). The team concluded that the number of repetitions performed at a given percent of 1RM is influenced by the amount of muscle mass used during the exercise, as more repetitions can be performed during the back squat than either the bench press or arm curl. The training status of the individual was seen to have minimal impact on the number of repetitions performed at relative exercise intensities. The implications for athlete and coach searching for increased maximum strength are fairly obvious in this respect; the number of repetitions employed at all percentages of 1RM should reflect the amount of muscle mass recruited by the exercise, ie the greater the muscle mass the exercise recruits, the more repetitions the athlete should complete.

by the stress of the workouts. It's possible that they could simply have been too tough and created a negative hormonal response in the survey's participants with particular reference to **cortisol** – of which more later.

## Conclusions

Gaining the maximum amount of strength from your weight training is a far from simple matter. As has been indicated, factors such as intensity, rests and hormonal response all play crucial roles. This is not helped by the huge amount of research, which is often contradictory. Although intensity seems to be

## Training to failure

It was indicated previously that forced repetitions can bring about superior strength gains. However, research by another Spanish team provides yet another variation in physiological response(7). Their research involved an 11-week programme of weight training to failure and non-failure. This was then followed by an identical five-week peaking period of maximal strength and power training for both groups involved in the study. The team examined the underlying physiological changes in basal circulating anabolic and **catabolic** hormones. Forty-two physically active men were matched and then randomly assigned to a 'training to failure' (RF) group, a 'non-failure' (NRF) group and a control (C) group. Muscular strength and power were measured – the former by 1RM and the latter by bench throws. Blood analysis was also employed to determine basal hormonal concentrations. These tests were performed before and after six, 11 and 16 weeks of training. Both RF and NRF resulted in similar gains in 1RM bench press (23% to 23%) and parallel squat (22 and 23%); muscle power output of the arm (27 and 28%) and leg extensor strength (26 and 29%); and maximal number of repetitions performed during parallel squat (66 and 69%).

However, the RF group experienced larger gains in the maximal number of repetitions performed during the bench press. In terms of the peaking phase, prior NRF resulted in larger gains in muscle power output of the lower extremities, whereas after RF it resulted in larger gains in the maximal number of repetitions performed during the bench press. The researchers explained this (again) as a consequence of hormonal response. They noted that during the peaking phase, the NRF protocol resulted in reduced resting cortisol concentrations and an elevation in resting serum total testosterone concentration. This is a hormonal combination ripe for positive strength adaptation – high levels of cortisol are negative for optimum strength training adaptation – as noted in chapter 1. The researchers concluded that their investigation demonstrated a potential beneficial stimulus of NRF for improving strength and power, especially during the subsequent peaking training period. However, performing sets to failure resulted in greater gains in local muscular endurance.

the most important factor in achieving greater strength, it will be up to coach and athlete to carefully monitor and crucially plan their training to achieve the greatest returns, using the systems that best suit their needs and those of their sport.

## References

*1) Can J Appl Physiol. 2004 Oct;29(5):527-43*
*2) Indian J Physiol Pharmacol. 2001 Apr;45(2):239-44*
*3) J Strength Cond Res. 2006 Feb;20(1):73-81)*
*4) J Strength Cond Res. 2006 Nov;20(4):819-23)*
*5) J Strength Cond Res. 2006 Nov;20(4):978-84)*
*6) J Sports Med Phys Fitness. 2004 Dec;44(4):361-7)*
*7) J Appl Physiol. 2006 May;100(5):1647-56. Epub 2006 Jan 12)*

# Boosting power – weight training and plyometrics

**Weight training on its own will not maximise sports performance – various other training methods need to be coupled with it in a training programme to achieve this. It is even possible to combine these other training methods in the same workout, in order to create specific training outcomes that can enhance performance to a greater extent than weight training alone.**

Power combination training describes power-developing workouts that combine weights and plyometric exercises; this can be done in various ways. Power combination workouts were greeted with great acclaim when research indicated that they could significantly enhance **fast twitch muscle fibre power** and therefore dynamic sports performance. However, other recent research has highlighted a number of complications, considerations and new potentialities for this type of workout.

The key physiological vindication of these workouts centres on 'potentiation'. This references the influence that one training mode can have on another in terms of enhancing fast twitch muscle fibres' ability to generate greater force more quickly. Initially research focused on the potentiation of the plyometric (jumping) exercise by the weight exercise. Note: the exercises involved are 'paired' and work the same muscle groups, ie the squat and the squat jump, which target similar leg musculature. Other research has looked in the other direction to see whether weightlifting power could be enhanced by the prior performance of a plyometric exercise – of which more later.

Fast twitch muscle fibre holds the key to increased dynamic sports performance. These fibres can contract two to three times faster than their slow twitch type I fibre counterparts. Type IIb fast twitch fibres, as opposed to type IIa 'transitional' fast twitch fibres, are the turbocharger in the power athlete's engine (note: type IIa fibres can be trained for greater endurance or out-and-out power expression subject to the 'right' training). However, type IIb fibres are notoriously difficult to fully activate. Physiologically there can be a large number of them to only one motorneuron (1:1,000) in their muscle motor unit. A motorneuron functions as a kind of ignition key to its bundle of power-producing fibres. Under normal training and competition situations, 'turning the key' requires a highly focused and/or 'psyched' mental state. Going through the motions will not excite type IIb fibres sufficiently to achieve a PB weightlift or series of hops. In fact, it's argued that weight training on its own may only recruit relatively low amounts of type IIb fibre, primarily targets type IIa fibres and actually converts type IIbs to IIas. This means that a weight-training programme for a sprinter, for example, could actually slow them down (type IIa fibres will not produce as quick and powerful contractions as type IIb fibres). Plyometric training, however, because of its ability to generate huge amounts of force in a split second, is much better at hitting type IIb fibres and therefore increasing speed and force production.

The way plyometric and weights exercises are ordered in a power combination workout can have a significant effect on training adaptation. There are two basic ways of doing this:

- **Complex training** involves performing sets of related weight training exercises before sets of plyometric exercises, eg three sets of 10 half squats before three sets of 10 jump squats – these are the 'complexes'.
- **Contrast training** involves performing one set of the weights exercises first and then a plyometric exercise afterwards for a given number of sets, for example, one set of 10 half squats followed by one set of 10 jump squats, repeated over three sets.

It is argued that the weights exercises for both complex and contrast training workouts should be in excess of 70% of **1 repetition maximum** (1RM). It's argued that a lighter load is insufficient to hit type IIb fibres sufficiently and cause potentiation.

Although a great deal of research points to the success of power combination workouts, a number of question marks have been raised over their claims – not least the issue of potentiating plyometric performance in the first place. Jones and associates looked at complex training and the effect heavy squats had on **counter-movement jump** (CMJ) and **depth jump** (DJ) height and **electromyographical** (EMG) activity in the subsequent plyometric exercise(1).

Eight strength-trained men were involved in the research under two conditions. During the first complex training condition the athletes performed 5 squats at 85% of 1RM, followed shortly afterwards by the first set of jumps. The second, third and fourth sets were performed three, 10, and 20 minutes post squatting. The second control condition involved only CMJ and DJ performance. The team discovered no positive potentiation for any CMJ performance variable or EMG activity regardless of muscle or phase of jump, nor were there any significant effects of the squats on DJ performance. However, EMG activity in the biceps femoris (hamstrings) during the propulsive phase of the DJ was found to be significantly higher (although this did not improve jump performance). All this led to the researchers concluding that complex training did not enhance plyometric muscular activity.

There are a number of potential explanations for Jones' team's findings. Firstly, it is possible that greater exposure to the complex training workout could have brought about a greater improvement in plyometric performance. The fact that higher EMG activity was discovered in the hamstrings during depth jumping indicates that more fast twitch fibres were being recruited and that in time they could have provided more propulsive power. Secondly, the order of the exercises could

**Jargonbuster**

**Electromyography** – measures the amount of electrical activity in a muscle. The more there is, the greater the amount of muscle fibre activation

### Jargonbuster

**Counter movement jump** – jump performed with an initial knee bend and immediate leg extension.

**Depth jump** – jump performed by stepping off of a low platform (30-70cm high), to land on one or two feet. Immediately on landing a jump for height or for distance is performed.

have affected the outcome – ie had a contrast methodology been used the results, might have been different (research has indicated that the contrast method may be more appropriate for those with little experience of power combination training or lower strength level – of which more later).

Research by Duthie and associates examined jump squat power in both complex, contrast and what they call 'traditional' training workouts[2]. Eleven women with different strength levels participated in a familiarisation session and then in three randomly ordered testing sessions. Session one involved completing sets of jump squats before sets of half squats (this they called the 'traditional method'). Session two involved sets of half squats before jump squats (complex method). Session three involved the alternation of sets of half squats and jump squats (contrast method). The research findings indicated no significant enhancement of jump squat performance for the traditional, contrast and complex methods for the lower strength trained group. However, the team did find that prior levels of strength had an effect. The stronger women had superior jump squat performances as an outcome of the contrast training. Hence it was concluded that contrast training was advantageous for increasing power output, but only for athletes with relatively high prior strength levels.

Although this research places a further potential question mark over power combination workouts, it is possible to see more than a glimmer of hope with the response of the stronger women to contrast training. Other research, such as that by Gourgoulis, has also indicated the importance of prior strength levels on power combination workout outcomes[3]. It was discovered that pre-squatting significantly enhanced the vertical jumping ability of their surveys' stronger participants by 4.01% and that of the weaker group by 0.45%.

In practical terms, this means that coaches need to be mindful of the strength levels of their athletes and be willing to implement (and experiment) with the ordering of the power combination workout training elements in order to achieve the most significant adaptations. They should also be prepared to vary the loading of the weight's exercises (between 70-90% of 1RM) and the number of repetitions. Recording the results will highlight which workouts produce the best results and the physical attributes of the performer that may need to be worked on to produce the best potentiation gains.

Like strength, the training maturity of the athlete should also be considered as an important factor in the potential success of power combination workouts – particularly when it comes to exercise ordering. Research by the Soviet sports scientist Yuri Verkhoshansky (widely believed to the 'father' of plyometric training) indicated that novice track and field athletes developed less explosive strength when they performed heavy weights exercises before their plyometrics. This contrasted with a group who put their explosive work first over the same 12-week training period. These findings may simply reflect the fact that the heavy squatting tired the athletes' relatively untrained muscles to an extent that impaired subsequent explosive performance.

The length of the rest periods between exercises is a further source of power combination workout debate. A complex training workout in its 'purest' form is designed to create an almost immediate potentiation effect. The rest between exercises and sets is normally about two minutes, which is long enough to minimise fatigue and short enough to optimise power output during the subsequent sets of exercises. (Note: some power combination workouts are designed to deliberately develop power endurance and use shorter recoveries and greater numbers of exercises. These workouts are applicable to sports like basketball and rugby, which require the athlete to combat greater levels of fatigue than say a long jumper).

Research by Fastouros[4] considered the rest factor and the value of combined training methods. Forty-one healthy men were divided into three training groups – all had their maximum squat and vertical jump bests previously established. Group one performed weight-training exercises only, group two plyometrics only and group three plyometrics and weights exercises on the same day, but crucially not during the same workout. This group performed the weights exercises first, and then around three hours later the plyometrics. Could potentiation last this long over this 'extended' complex workout? The team found that although all training methods improved vertical jump and squat performance, those that combined plyometrics with weights on the same training day experienced the greatest performance enhancement. As an example, their maximum squat improved by 36kg, which compared to 16.4kg for the weight-training group and 28kg for the plyometric group.

Fastouros' research has positive implications that could be very useful for those embarking on power combination training. Separating the two training elements on the same training day with a greater recovery could avoid fatigue, yet still maintain potentiation. As with performing plyometric exercises first, this

### Potentiating weight training by the use of plyometric exercises

It was noted that most power combination training research has focused on the potentiation of the plyometric exercise by the weightlifting exercise in the same workout. Much less attention has been paid to the reverse potentiality, ie the effect the plyometric exercise may have on the weight training exercise. Research by Masamoto considered just this, and in particular the effect of plyometric exercises on 1RM squat performance(5). Twelve trained men participated in three testing sessions separated by at least six days of rest; during each 1RM was assessed. In the first testing session subjects performed a series of weights sets with increasing loads until their 1RM was determined. During the second and third testing sessions subjects performed either three double-leg tuck jumps (TJ) or two depth jumps (DJ) 30 seconds before each 1RM attempt. Three 1RM attempts were allowed and at least four minutes' recovery was taken between each attempt. The researchers discovered that performing the plyometric exercises first, before going for a 1RM maximum, had a positive effect. Tuck jumps upped the groups' collective squat performance to 140.5kg, and prior depth jumping to 144.5kg. With no plyometrics the group managed only 139.6kg. This is obviously very encouraging news for power- and weightlifters and anyone looking to increase general muscular strength via weight training, as it indicates that plyometric potentiation can work.'

## Boosting competitive performance

Most power combination workout research has tended to focus on the potentiation of training performance, but it stands to reason that if one form of dynamic exercise can prep another in the training environment, it should also be able to do so in the competitive one. Research by Mathews and team looked at the effect of pre-squatting on 20m sprint performance(6). There were two experimental conditions. During the control condition, the participants sprinted 20m, rested for 10 minutes and then repeated the 20m sprint. During the experimental condition, the second sprint was preceded by five squat repetitions with a load equal to each participant's five repetition maximum (5RM) times were recorded, and the results showed a mean improvement of 0.098 seconds when the second sprint was preceded by the back squats. During the control condition, no improvement was observed between the first and second sprint.

Similar findings were made by Smith and associates; these researchers looked at the effect squats had on a very intense 10-second bout of sprint cycling(7). Their research differed from that of Jones in that the time between squatting and cycling (in this case) performance was varied over three conditions. Nine men were involved. In session one, the 'control' session, they performed a 1RM squat attempt immediately before the 10-second sprint cycle. For session two, 10 x 1 squats were performed at 90% of 1RM, followed five minutes later by the cycle sprint. During the third test condition, the same test protocols were used as for the five-minute test session except for the fact that the subjects rested for 20 minutes prior to the sprint cycle test. The researchers discovered significant increases in average power and average power relative to body weight for the five-minute test condition. The team concluded that their particular five-minute squat protocol could have a very positive potential carry-over effect for improvements in activities like 100m sprinting.

All to be completed five minutes before competition. The implications of this research are potentially huge. Here are some practical pre-competition workout suggestions. Do experiment with them in a training environment first – all to be completed five minutes before competition:

- Sprinting/jumping/throwing – perform three single-leg squats on each leg.
- Sprinting/jumping/throwing – perform five squats with a willing training partner/ team mate on your back.
- Weightlifting – perform five throw and catch medicine ball chest passes against a wall as fast as possible and/or complete three tuck jumps or depth jumps.
- If near a weights room perform 3 x 1 90% 1RM squats, with three minutes of recovery between sets.

## Jargonbuster

**Fast twitch muscle fibre –** muscle fibre utilised for power activities, such as sprinting. Has a speed of contraction ('twitch' rate of 30-70 a second).

**1 repetition maximum (1RM)** – the maximum amount of weight able to be lifted on one attempt.

could prove particularly beneficial for enhancing novice athletes' power.

Despite some of the issues that have been raised, power combination training still seems to offer a great deal for those in search of increased fast twitch muscle power. But the premise that simply performing a complex training session will, for example, enhance power output, must not be taken for granted. Rather, coaches should carefully analyse prior strength levels, training maturity, training programmes and the types of power combination workouts that can be utilised for their athletes, in order to get the most from them. Monitoring and evaluation are a must. The immediate effect that potentiation can have on competition is incredibly exciting, but again, careful experimentation is needed.

## References

*1) J Strength Cond Res. 2003 Nov;17(4):694-700*
*2) J Strength Cond Res. 2002 Nov;16(4):530-8*
*3) J Strength Cond Res. 2003 May;17(2):342-4*
*4) J Strength Cond Res. 2001 Nov:14(4), 470-476*
*5) J Strength Cond Res. 2003 Feb;17(1):68-71*
*6) Res Sports and Medicine. April/June; 2004 12(2)*
*7) J Strength Cond Res. 2001 Aug;15(3):344-8*

# How long do you need to rest for between sets in order to derive maximum power and strength from your weight training?

**Length of rest period between reps and sets when weight training can have a surprisingly large effect on developing maximum strength, power and building lean muscle. John Shepherd explains**

## Maximum strength, power development, weight training and the thoughts of Tudor Bompa

Maximum strength is achieved by lifting weights that are as heavy as possible – 80-100% of 1RM, over low 1-4 rep ranges. In contrast power is generally argued as being developed using medium to heavy weights – 60-80% of 1 RM and medium rep ranges 6-12. Most coaches will probably argue that both require relatively long recoveries between sets, if the athlete is to achieve 'maximum strength and power promoting quality lifting' with little fade. However, when pressed as to exactly how long the athlete should recover between sets and reps, they may be less sure. Whereas a couple of minutes might be enough for a maximum strength-developing session comprising 3 x 3 reps at 90%1RM, will it be enough for a 4 x 10 reps at 75% of 1RM power sessions – where the weights are moved as fast as possible? Some may also argue that a shorter recovery is best, due to a greater hormonal, muscle-building response (see chapter one).

Tudor Bompa is one of the world's foremost strength and conditioning experts. He has a background of both research and practical coaching. He is the only coach to have produced an Olympic champion in a power event (javelin) and a world champion in an endurance event (rowing). He has devised numerous strength-training protocols for what he calls the 'periodisation of strength' – the progressive development of strength through various resistance training methods, notably weight training, which are specifically relevant to improving sports performance[1].

Limitations on space prevent a detailed analysis of Bompa's theories; however, a focus on what he calls 'the maximum load method' will act as a useful starting point for the analysis of rest between reps and sets when weight training. Bompa believes that this type of strength development is most important when it comes to producing strength that will directly benefit a power athlete. He provides the following (selected) reasons:

1) It increases motor unit activation, resulting in high recruitment of fast twitch fibre.
2) It has a high neural (mental focus) requirement, which can translate to improved sports performance by enabling the increased recruitment of fast twitch muscle fibre.
3) It is important in sports where increased power is required but without an increase in muscle mass – which could increase the athlete's weight and therefore interfere with power and performance capability.
4) Improved synchronisation of muscle groups under heavy loading will result in improved sports performance, as the 'smoother' and better skilled an athlete is at performing a powerful activity, while recruiting maximum amounts of fast twitch muscle fibre, the better they will be at performing dynamic sports skills.

For Bompa, rest is a crucial training variable in the development

### Why the need to develop maximum strength for speed and power sports?

Bompa believes that speed, power and agility can only be significantly enhanced by the development of increased maximum strength, predominately created via the periodisation of strength and a maximum load phase. Basically, if the athlete is able to recruit stronger and more fast twitch muscle fibre, they will become more powerful, faster and more agile. Training for power alone is not enough to achieve this.

of strength and power through the maximum load method. This is clearly put into context by the requirement of these workouts to create, as he puts it, 'the highest possible tension in a muscle'[(2)]. Consequentially, exercises must work the prime movers involved in the athlete's chosen sport – the calf muscles, hamstrings, quads, glutes and hip-flexors of the sprinter, for example. And the reps must be low (1-4) to enable the athlete to achieve the highest possible muscle tensions. Crucially, the rest period must be long enough to enable a 'full-out attack' on each lift. Athletes will know that they only have a certain amount of 'energy' (physically and, critically, neurally) for these types of workouts. Bompa is 'sports science'-aware of this and argues that only 3-5 exercises should be included in a workout. If there were more, the athlete would not be able to neurally and physically maintain the desired workout intensity. Specifically, and in the light of the subject matter of this article, he advocates a recovery of between 3-6 minutes between sets for optimisation of performance. Six minutes may seem an awful lot of time between a set comprising of perhaps only two lifts, but it is argued that it is needed to allow the athlete to put maximum effort into each lift. 'To stimulate the necessary physiological and morphological central nervous system changes, a higher number of sets should always take precedence over a higher number of reps,' writes Bompa. Not only does he argue this from 'a maximum commitment on the part of the athlete's perspective', but also from one that allows the body's

**Jargonbuster**

**Mesocycles –** medium-length training phases, lasting usually 3-6 weeks.

**Post-activation potentiation –** performing a dynamic exercise before another one can fire up the neuromuscular system to enhance the performance of the subsequent exercise.

high energy body compound providers – creatine phosphate and adenosine tri-phosphate (ATP) – ample time to replenish between sets, therefore providing plenty of fuel.

## Recovery and hormonal response

Athletes and coaches may rightly believe that shorter recoveries induce greater muscle hypertrophy (growth), especially when combined with lifting medium to heavy weights fast. This is a protocol used extensively in body building (this premise was analysed extensively in chapter 1). They may believe that this is the best way to improve sports speed, for example. Training in such a way will boost production of growth hormone and testosterone (the key androgens) and increase the potential for increased muscle size, as well as developing muscular power. As a larger muscle is often equated with greater power potential, it is easy to see this correlation. However, as noted this could be detrimental to sports performance from a gained weight perspective for athletes where **power to weight ratio** is crucial. Crucially, as Bompa's work exemplifies, a muscle can be made to be significantly more powerful without a significant increase in size. And in order to achieve this, the rest period between sets and reps is very important.

## Shorter recoveries promote greater hormonal response

To provide further background: a growing body of research indicates that the shorter the recovery between sets and reps and the use of medium to heavy weights, over eight to 12 rep ranges, the greater the androgen release will be. For example, Brazilian researchers discovered that 30 seconds' recovery between sets for women who performed the same 4-exercise lower body weights programme produced superior growth hormone release compared to 60- and 120-second rest periods[(3)]. Incidentally, no difference was discovered between the 60- and 120-second protocols. Other research has indicated that the more dynamic the exercise the greater the hormonal response[(4)].

## Greater recovery produces increased power

Researchers from Australia looked at the effects that breaking down a 6-rep maximum session (this requires the athlete to lift a load that would induce failure on the seventh rep if performed) into single-, double-and triple-rep had in regard to strength gains[5]. To clarify three 'inter-repetition' groups were established:
1) Singles group = 6 x 1 repetition with 20-second rest periods between each repetition.
2) Doubles group = 3 x 2 repetitions with 50 seconds between each pair of repetitions.
3) Triples group = 2 x 3 repetitions with 100 seconds' rest between each 3 repetitions.

Twenty-six elite junior male basketball and soccer players performed bench presses using their 6RM load. The power output for each repetition was recorded. The researchers discovered that significantly increased power outputs (25-49%) were achieved over the later repetitions (4-6) of the singles, doubles and triples loading schemes. Significantly greater total power output (21.6-25.1%) was observed for all inter-repetition rest interventions when compared to traditional continuous 6RM total power output. Interestingly, no significant differences were found between the groups. This led the researchers to conclude that, '…utilising inter-repetition rest intervals enables greater repetition and total power output in comparison to traditional loading parameters.' This would equate to greater power potential to be tapped for specific sports training and competition – subject to a relevant sport-specific conditioning programme.

Researchers from Illinois took a similar theme. Their study compared squat strength gains and volume (total amount of weight lifted) when resting for 2 minutes or 4 minutes between sets over multiple **mesocycles**[6]. Fifteen trained men were matched and randomly assigned to either a 2-minute (7 members) or a 4-minute (8 members) rest interval group. Each performed the same training programme. Two workouts were performed each week; one was labeled 'heavy' and the other 'light'. The workout intensity was varied, as were the number of sets and repetitions – but the designated recovery periods were kept the same. The researchers looked at the differences in strength gains and the loads, intensity, volume and repetitions utilised per set and compared these between the groups.

So what was discovered? Both groups demonstrated large strength gains, although these differences were not significant between the two groups. However, during all mesocycles, the 4-minute group demonstrated significantly higher total volumes for the heavy workouts – they were able to lift more weight in consequence to the longer recoveries. The team therefore concluded that, '…athletes attempting to achieve specific volume goals may need longer rest intervals initially, but may later adapt so that shorter rest intervals can be utilised without excessive fatigue, leaving additional time to focus on other conditioning priorities.' This research provides part corroboration for longer recoveries between sets when weight training for increased strength. It is possible to suggest that after the gains in strength for the high-volume group began to tail off over a number of mesocycles, a different training methodology should have been implemented to capitalise on volume and other gains – which might take the strength gained via the previous methodology to a higher level.

At this point it is crucial that we understand that sports strength is different to 'strength gain for strength gain's sake only'. Gaining strength is an adjunct – although a crucial one – to the conditioning needs of the athlete (as Bompa's theories exemplify). There is no point in gaining strength for athletic purposes unless it is usable – hence the need for a specifically prepared and relevant training programme.

## Exercise order as a rest factor

The order of exercises in a weights workout can have a significant influence on the outcomes of a workout and should be considered as a rest variable. Consider this: if an athlete performs all their sets on one exercise consecutively with a

### Jargonbuster

**Immediate and short-term anaerobic energy systems** – energy systems that produce quick, powerful muscular contractions. They have little reliance on oxygen and provide energy for no more than 90 seconds.

**Motor unit** – nerves and bundles of muscle fibre that produce muscular action in a specific muscle.

specific rest period, is this the same as performing the same exercises after three, four or five others have been performed before it in a circuit-style workout?

Very few research studies have actually explored this theme. However, one research team from Holland conducted a study[7] in order to 'examine the effect of exercise order on back squat performance in the context of a whole-body workout'. Nine resistance-trained male subjects performed back squats, using a system of 4 sets at 85% of 1RM, on 2 separate occasions:

**Protocol A:** the squat was performed first.

**Protocol B**: the squat was performed after a whole-body resistance-exercise session.

The researchers measured the number of repetitions, average power and rating of perceived exertion (RPE) for each protocol from the subjects. So what was discovered? All subjects performed significantly more repetitions during the first set of protocol A compared with protocol B. Perhaps surprisingly, the average power for each set was higher during protocol B compared with protocol A. There were no significant differences in RPE values between the 2 protocols. The team summarised their findings thus, '…performing the barbell back squat first in an exercise session allowed the completion of more total repetitions.' There was, however, a 'however', and this reflected the specific exercises in the study, which could explain why protocol B produced higher power. Specifically, it was theorised that greater power output for the squat was more than likely attributable to the preceding power exercise, the hang pull and post-activation potentiation (see chapter 3 for a detailed consideration of potentiation).

## Conclusions

The length of the rest period between exercises and sets in a weight-training workout can have a big influence on the outcomes of a workout, as can the order of exercises as a rest variable, and this can have crucial sports training implications. The coach/athlete must think carefully about this and general weight training programme design, if he or she wishes to maximise sports-specific transference. It appears that for increasing speed and power, the recovery needs to be longer than may have been previously thought – for example, 3-6 minutes for maximum load weight training. Potentiation of exercises should also be considered, as should hormonal response.

## References

*1 and 2) Periodisation Training for Sports (2nd edition), Bompa T, Human Kinetics 2005 (and 2) p174*

*3) J Sci Med Sport. 2007 Dec 17*

*4) Indian J Physiol Pharmacol. 2001 Apr;45(2):239-44*

*5) J Strength Cond Res. 2006 Feb;20(1):172-6*

*6) J Strength Cond Res. 2008 Jan;22(1):146-52*

*7) J Strength Cond Res. 2006 Feb;20(1):141-4*

### Jargonbuster

**Fast twitch muscle fibre –** speed- and power-producing muscle fibre.

**Power to weight ratio –** if body weight gains can be minimised (or even reduced) while power and strength levels are increased, then an athlete’s power to weight ratio is improved, thus boosting sports performance.

# Can you weight-train and maximise your endurance?

**Endurance athletes and their coaches will weight-train, although they may be sceptical of the direct benefits that the former can have on the latter. In this chapter we look specifically at whether weight training has a role to play in the training of an endurance athlete.**

Let's begin with the assumption that weight training benefits endurance athletes, with a focus on rowing. Rowing requires an anaerobic contribution of about 30% to the 2k Olympic race distance. In consequence, rowers often train their long-term anaerobic system with high-intensity, short duration intervals (lasting from 30 seconds to five minutes), with very short – often one-to-one – recoveries. These workouts target slow and fast twitch muscle fibres – the latter providing much of the power needed for these turbocharged efforts.

Logic says that weight training these fibres will be beneficial, especially when you consider that the actual rowing race is completed in about six minutes, using 200-240-plus strokes – an amount of 'repetitions' that could easily be accrued in a standard-power (70-80% of 1RM) weight training workout, comprising 4x10 repetitions of 6 exercises.

However, logic does not always apply, and this type of weight training (and indeed other types) may actually offer little direct benefit to rowers when it comes to improving their endurance. Bell and associates looked at the effects of three different weight-training programmes on 18 varsity rowers during their winter training[(1)]. One group performed 18-22 high-velocity, low-resistance repetitions, while another did low-velocity,

**Jargonbuster**

**Lactate** – chemical present in the body at all times. Its levels increase in regard to exercises.

high-resistance repetitions (6-8 reps) and a third did no resistance training at all. All resistance exercises were rowing-specific and were performed on variable-resistance hydraulic equipment four times a week for five weeks, while the subjects continued with their normal endurance rowing training.

Which group's rowing improved the most? When subjects were tested on a rowing ergometer, the researchers found no difference between any of the groups in terms of peak power output or peak **lactate** levels. So the weight training apparently served no purpose. Similar findings emerged from a US study, when elite male weight-training rowers displayed no increase in **VO2 max** by comparison with a rowing-only group, who improved their VO2 max by up to 16% during pre-season training(2).

Considering another endurance sport, Tanaka looked at the effects of weight training on 24 experienced swimmers over 14 weeks of their competitive season(3). The swimmers were divided into two groups of 12, matched for stroke specialities and performance; one group performed weight training three days a week, alternating this with their swim workouts, while the other group did no weight training at all and just swam. Both groups trained for eight weeks.

Weights – both fixed and free – were selected for their swimming specificity. The swimmers performed three sets of eight to 12 repetitions on lat pull-downs, elbow extensions, bent arm flys, dips and chin-ups. The weights were progressively increased over the duration of the training period, with a tapering period two weeks before their major competition. The result? As with the rowing studies, weight training failed to improve performance, despite the fact that swimmers who combined resistance and swim training managed to boost their strength by 25-35%.

Paavolainian and his co-researchers considered the effect of weight training and other power training methods on the performance of cross-country skiers – long considered the ultimate aerobic athletes(4). Seven skiers performed power weight-training exercises (performed at high velocity against a moderate-to-high loading) as well as plyometric (jumping-type) exercises for three weeks, while another group of eight skiers performed strength-endurance high-repetition weight training for the legs and arms. Both groups also continued with their normal endurance training. At the end of the study period, the researchers found no difference in measures of endurance capacity, such as VO2 max and anaerobic threshold, between the two groups. In short, the various weight and plyometric training sessions had not enhanced skiing performance power.

Could there be any mitigating circumstances for the results that indicate that weight training has little relevance to enhancing endurance performance? Tanaka introduced weight training into the competitive phase of his swimmers' training cycle – perhaps not the best time. It is possible that, at this stage, the swimmers' performances could have been *impaired* rather than improved by the added training load.

Paavolainian's plyometric power training cross-country skiers did increase their ability to express peak power, although this is not much use to these athletes, whose prime requirement is a highly developed aerobic system. It may be, as the Polish exercise scientist Saziorski suggests, that since cross-country skiing is an ultra-endurance sport, weight training has little direct relevance to performance in the first place(5). In fact, Saziorski believes that maximum strength is of little importance in sports with a maximum strength requirement of less than 30%.

The rowing findings are more difficult to explain, but there is a possible answer. It is argued that when an endurance athlete reaches a certain level of performance strength – which can be developed through their everyday CV training or with weights or other resistance training – further improvements in weights-based strength will not create further improvements in performance. Since the rowers in the above-mentioned studies were all performing at a high level already, it could be argued that they had developed enough 'performance' strength, through years of correctly-executed rowing technique.

Shepard offers a very succinct explanation for why weight and endurance training can make for poor bedfellows(6). 'Some of the most important and influential factors that result from physical

### Jargonbuster

**VO2 max –** maximum amount of oxygen that can be processed by the body.

**Slow twitch muscle fibre –** also known as Type I or 'red' muscle fibre. Used to sustain endurance activity, has high oxygen-processing capability.

conditioning occur at the cellular level in the muscles, that is, the majority of training effects are peripheral,' he further explains. 'Training is specific and selective of the types of muscle fibres used. That selectivity will determine the nature of training effects and the type of performance that is improved.'

Essentially what he is saying is that training different energy systems at the same time can produce a confused physiological state – the so-called 'interference effect'. How can pure high-power fast twitch type IIb muscle fibre be expected to gain in its size and power-generating capacity through weight training if it is being relentlessly bombarded in the same training phase – indeed the same workout – by extensive long, slow distance work or intense interval training? Training that, while bolstering its type **I slow twitch muscle** fibre counterparts, also causes its type IIa cousins (which generate intermediate power) to defect to the slow endurance side? Depending on the training stimulus, all these muscle fibres can become orientated more towards endurance or power/speed.

So here's the million-dollar question: is there any real benefit to be gained from weight training if you are an endurance athlete? To determine this for yourself, you need to look at the specific strength requirements of your sport. If you're a cross-country skier, or marathon runner, weight training may not be relevant to improving your performance, as you cannot construct a session in the gym that directly replicates what you'll go through in a race.

However, weight training used in combination with other types of resistance training should not be discarded: marathon runners, for example, should expect to improve their performance by improving their foot strike, through plyometric and running drills and specific weights exercises, like the split squat and lunge. The key for them – and for similar endurance athletes – is to construct a training programme that channels their resistance training gains into strength that will improve their technical performance.

Circuit resistance training (CRT) has been shown to offer a great deal to endurance athletes as it targets type 1 muscle fibre (and type IIb), can develop VO2 max and lactate threshold and will also have a limited effect on increasing strength (see PP 105, June 1998, p2). For best results use a weight set at 50-60% of 1RM, since this seems least likely to interfere with the development of enhanced endurance capacity.

You may have noticed an apparent contradiction, in that some of the studies quoted earlier did actually use CRT-style training, but to no effect in terms of improved endurance performance. This can be explained with reference to the training variables of order and recovery.

The studies by Tanaka and Paavolainian, for example, simply threw all the training ingredients together into the workout mix without taking order and recovery into account. Taking training unit timing into consideration, Sporer et al looked at the effects of weight training on aerobic/anaerobic CV performance in 16 male collegiate athletes[7]. The aim of the study was to see whether the type and intensity of aerobic training affected concurrent weight training after four, eight and 24 hours of recovery. One group performed steady-state work at 70% of maximum heart rate, while the other performed 95-100% intervals with 40% MHR recoveries. Both groups were then subjected to 1RM maximum strength testing on bench press and leg press.

The researchers found that for both groups, weight-training gains were compromised by the endurance work unless adequate rest was allowed. More specifically, the participants' leg muscles were negatively affected by their aerobic training in the leg press test, although bench press performance was unimpaired. In consequence, they made the following recommendations for athletes performing concurrent training:

- If you must perform both workouts within a single day, allow at least eight hours between aerobic training and strength training.
- Lower body strength training should not be performed on the same day as aerobic training.

Expanding further on these suggestions, the athlete/coach could also consider developing strength in a specific training

### Jargonbuster

**Microcycle –** training period lasting a week to 10 days.

**Lactate tolerance –** well-conditioned endurance athlete's bodies will be better able at using and processing the build-up of exercise induced lactate levels.

cycle, removed from endurance training. This might be particularly helpful at the beginning of the training year, when strength gains, without the interference effect, could be maximised. Periodic returns to weight-training **microcycles** could then be used to top up strength levels.

Under such conditions, Canadian researchers found that a group of rowers who strength-trained for five weeks before five weeks of endurance training were rewarded with a 16% increase in VO2 max and a 27% improvement in **lactate tolerance**[8]. By contrast, rowers who trained in the reverse order boosted VO2 max by only 7% and showed no improvement in lactate tolerance. The explanation? The strength-before-endurance group gained quality rowing muscle without compromise and were able to use it to row harder and faster, with greater fatigue resistance, during endurance training. Working out for weight training gains alone may have enabled them to push beyond their 'normal' previously conditioned rowing power levels.

Finally, if you are an endurance athlete you should use weight training to avoid injury, since it is almost beyond dispute that weights and resistance-training exercises can protect against injury by strengthening soft tissue.

## References

*1) Journal of Sports Sciences, 7 p 205-214, 1993*

*2) Medicine and Science in Sport and Exercise, vol 26 (5) p575 1994*

*3) Medicine and Science in Sports and Exercise, 25, p952-959 1993*

*4) European Journal of Applied Physiology, 62, p251-255 1991*

*5) In Dick F – Sports Training Principles p238 A and C Black 4th edition 2002*

*6) Canadian Journal of Applied Sport Sciences 3, p9-15 1978*

*7) Journal of Strength and Conditioning Research 17 (4) p638-644 2003*

*8) Canadian Journal of Applied Sport Science vol: 13:4 p214-219 1988*

# The Olympic lifts and variants – can they boost sports performance?

**BJ Rule is a firm believer in the benefits of the Olympic lifts and their variants as being of real importance for sportsmen and sportswomen, despite some recent criticisms.**

The Olympic lifts are the snatch and the clean and press. Derivatives of these include partial or hanging lifts, such as the hang clean and the hang snatch, where the bar is pulled from a position approximately level with the knees, for example, as opposed to being lifted from the floor. I have provided reasons why these latter lifts and others can be of real benefit to the sportsman and sportswoman and have provided key performance tips below. When learning the lifts, always start with a light weight and spend a lot of time learning how to lift properly. These moves are very dynamic and could lead to muscle and joint strain if poor technique is used.

## Five reasons why the Olympic lifts and their variants benefit sports performance:

### 1) They are performed from standing

This is important for a number of reasons. One of the most obvious is that the majority of sports are also performed from a standing position. There are, of course, exceptions, such as cycling and rowing (although I believe that Olympic lifting is also beneficial to them). Olympic lifting also develops proprioception (basically, the ability of the body to adjust to the forces transmitted through its limbs and muscles) and spatial awareness (the awareness of the body in space and the adjustments made consciously and unconsciously to, for example, maintain the robustness of a sports skill). The lifts are also beneficial for teaching the body to support and stabilise itself. And there's yet another reason: the way the Olympic lifts are performed mirrors the way force is applied in numerous sports, for example in basketball and football, where it is applied to the court/pitch, carried through the lower limbs, up through the body and transferred (often) through the upper limbs – the basketball jump shot being a prime example.

## 2) They involve multiple muscles

The Olympic lifts are compound muscle group exercises, as they work across numerous joints. This is important for time-saving reasons. Rugby and football players who are in team training, doing skills practice, speed work and other conditioning have limited time for strength training. But the Olympic lifts and their variants are 'bang for buck' exercises. They deliver a big hit, training-wise, in a relatively short space of time. For example, performing a snatch develops leg, hip, back and shoulder strength, just from pulling the bar from the floor, it also develops core and torso stability and strength throughout the movement. During the catch and recovery phases the ability to absorb a load is trained, and so are the stabilising muscles around the spine and shoulder joint and the legs, hips and back during these phases. The catch occurs when the bar is 'caught' overhead with the arms fully extended. The absorption phase occurs when the bar is controlled back to the ground. The ability to absorb a load is required for most sports: think of catching, being tackled, being hit.

## 3) They involve triple extension

Olympic lifts replicate the movement patterns involved in running, jumping, throwing, punching and tackling. The main pattern that is trained when performing these lifts and replicated in numerous sports is known as 'triple extension'. Triple extension involves the muscles of the ankles, knees and hips engaging synchronously to produce a dynamic movement.

As well as triple extension there is also the translation of force into the floor, through the body and limbs (see 1). A strong thoracic (upper) spine is extremely important in this translation of force through the torso and the limbs and this area is extensively developed in the Olympic lifts.

## 4) They develop high levels of motor unit recruitment

Speed is a key requirement for most sports – in fact, you can never be quick enough! Neuromuscular recruitment – the ability to recruit and contract as many motor units (bundles of muscle fibres and the nerves that spark them into action) as possible – is crucial for speed. I believe the Olympic lifts are fantastic speed developers. Why? The snatch, for example, is completed in a split second. In this blink of an eye the weight is lifted from the ground to an overhead position. Training fast will make you fast, and Olympic lifting makes you fast.

## 5) They increase range of movement and improve posture

We should be aware of the benefits of optimal range of movement and the importance of posture for athletic performance. When range of movement is limited and posture is poor, muscles aren't able to fire correctly. This limits performance and increases the chance of injury. The Olympic lifts and their variations can increase range of movement and improve posture. Range of movement is improved in key areas across the body. For example, in the hips this is greatly improved through the bottom position of the clean or the snatch for example. Stability and strength are also developed across the shoulder joint and the thoracic spine, when the bar is taken overhead and held and then brought down to the ground, as is the case with the snatch.

## Variation lifts

One of the cons of performing the Olympic lifts can be the learning curve taken to master them. This can be an issue, particularly if your weights sessions are just a part of your week's sports training. I believe this is where some of the variations of the Olympic lifts can be very useful, as learning them is slightly easier. Using various start heights or 'hang' positions can be extremely helpful, and the joint angles involved are shared with positions in many sporting movements.

### a) Power snatch from the hang

The power snatch from the hang is ideal for anybody who needs to develop power through the lower limbs, for example runners, long jumpers, footballers and rugby players. It is also brilliant for those who need to improve jumping combined with overhead power, for example tennis players (serving and overhead shots), volleyball players and javelin throwers. There are various hang positions – these can be from the hip, mid-thigh or just above the knee. The benefits, as well as those listed above, include the fact that the deep receiving position does not feature in this lift.

### b) Power clean

The power clean is a clean where the bar is received in a partial or semi-squat position only and does not involve the full squat position involved with the Olympic lift (clean and jerk).

### c) Power jerk

This exercise requires the bar to be taken to an overhead position from a hang position. Athletes such as boxers, athletic event throwers and tennis players can all benefit from the power jerk.

## The case against Olympic lifts and their variants

As an advocate of these lifts for my own training (rugby league focus) and for training a host of clients, including athletes from sports as varied as competitive runners, cyclists and professional rugby league players and international judo competitors, I have seen the benefit of these lifts. However, there are coaches who are very dismissive of the Olympic lifts and their variants, for example Tudor Bompa, one of the foremost strength training experts in the world (see chapter 3).

Bompa's main argument is that sprinters, for example, do not need to use pulling (extension) movements from the upper body when running. It is this aspect of the Olympic lift and their variants that makes them superfluous to their event. My counter-argument is that the upper body only plays a small role in the Olympic lifts – it is the lower body that generates the power to lift the bar vertically. Bompa, for example, simply advocates the calf raise, squat and hamstring exercises as the three key power exercises, whereas a single pull from the floor, like in a snatch or clean, covers all these lifts in one. Despite the thoughts of the great man, and with all respect to him, I believe that Olympic lifts do have a place in the training schedules of athletes who practise all sports. I have provided my reasons – what do you think?

# Getting more from the Olympic Lifts

**In chapter 6, BJ Rule looked at the benefits of the Olympic lifts and three specific variations of these lifts that can also be used as teaching exercises. He now considers three more Olympic lifts variations that can be used as stand-alone exercises or as progressive exercises that can be used in the teaching of the Olympic lifts**

Two of the three Olympic lift variants considered in the following are all performed from the hang position – that's with the bar held at arms' length in front of the shins, or between the hips and knees. The hang position is a great place to start from, particularly when you want to focus on the catch and receiving positions of the lifts. The third variant is performed with the bar at shoulder level.
The three new variants are:
- the snatch from the hang
- the clean from the hang
- behind the neck power jerk.

In the previous chapter the variants of the clean and snatch were both 'power' variations from the 'hang' position. The 'power' variation refers to the catch position and is a partial receiving position equivalent to the bottom position in the quarter squat, ie the bar is cleaned to the front of the shoulders and 'caught' there.

In this article the first two lifts start from the 'hang' position but finish in a full squat receiving position. The benefits in receiving the load in the full squat position include:
- the ability to absorb a load – this transfers well to contact

sports, such as the martial arts and rugby
- reaction time and foot movement – obviously critical to numerous sports
- increased range of movement – again, highly relevant to sports performance.

The benefits of starting from the hang position instead of from the floor are:
- it's a faster learning curve, ie a chunk of the technical requirements of the lift are removed leaving less to learn
- some athletes/trainers may have injuries or a reduced range of movement which hinders lifting the bar from the ground.

## a. The snatch from the hang

The snatch from the hang is fantastic as a stand-alone exercise, but it is also a great progression from the power snatch from the hang and as a developmental exercise for the full squat snatch. The snatch from the hang develops speed, explosiveness and power. It also improves posture and strength in the torso and upper limbs, as well as range of movement and strength in the hips and lower limbs.

## Key lifting technique tips
## Start position

- Feet shoulder-width apart
- Hold the bar using a wide grip in the hang position just above the knees, with hands approximately 25cm outside the line of the knees (note: this will be dependent on your body size and will vary)
- Body weight, plus the weight of the bar is distributed through the whole of each foot
- Knees are slightly flexed (bent) and a stretch should be felt in the hamstrings
- Hips are flexed and torso, chest and head are forward of the bar
- Lower back is arched, thoracic spine is extended and held tight, and head looks forward

● Arms are straight, with elbows locked

## Pull

● The pull is initiated by triple extension across the ankle, knee and hip which causes the bar to travel vertically
● Lower back remains arched, thoracic spine is extended and held tight and the head looks forward
● Chest, shoulders and head are still forward of the bar

## Jump

● The ankles, knees and hips are at full extension, so a jump action is performed (the feet may or may not leave the floor)
● The bar continues to travel vertically until at a position between the navel and the sternum

## Pull under

● As the bar continues to travel vertically, the body pulls under the bar
● The shoulders slightly shrug and the elbows begin to flex to absorb the load of the bar
● The ankles, knees and hips quickly flex to pull the body under the bar

## Catch/receiving position

● The upper body catches the bar overhead; the elbows extend and the shoulders contract
● The lower body simultaneously reacts so the heels contact the ground and the knees and hips are flexed and in the bottom of a full (deep knee-bend) squat position

## Recovery

● The bar is then 'stood up' by extending the knees and hips while remaining overhead

## b. The clean from the hang

The clean from the hang is similar to the snatch from the hang because the exercise works as a stand-alone exercise, a progression from the power clean from the hang and as a teaching exercise for the full squat clean. More weight can be lifted than in the power variant (as long as the receiving position is strong) as the bar does not need to travel as high. The clean from the hang is brilliant for developing off-the-mark quickness and explosives, as you need to move a lot of weight fast. This is great news for athletes whose movement, agility and first step are important – for example, sprinters, field and racket sport players.

## Key lifting technique tips
## Start position

- Feet shoulder-width apart
- The bar is gripped using a narrow, clean grip just outside the thighs, with the bar in the hang position just above the knees
- Body weight, plus the weight of the bar, is distributed through the whole of each foot
- Knees are slightly flexed and a stretch should be felt in the hamstrings
- Hips are flexed and torso, chest and head are forward of the bar
- Lower back is arched, thoracic spine is extended and held tight, head looks forward
- Arms are straight, elbows are locked

## Jump

- The ankle, knee and hip are at full extension so a jump action is performed (the feet may or may not leave the floor)
- The bar continues to travel vertically, but only needs to get as high as the top of the thigh/hip

## Pull under

- As the bar continues to travel upwards, the body pulls under the bar
- The shoulders shrug slightly and the elbows begin to flex
- The ankles, knees and hips quickly flex to pull the body under the bar

## Catch/receiving position

- The upper body catches the bar in the rack position on the shoulders with elbows high and wrists flexed
- The lower body simultaneously reacts so the heels contact the ground and the knees and hips are flexed as the body achieves a front squat position

## Recovery

- The bar is then 'stood up' by extending the knees and hips

## c. Behind the neck power jerk (snatch grip)

The behind the neck power jerk is a great exercise for developing speed and power; however, it is also suitable for increasing strength in the overhead position for the snatch. As well as developing athletic power, the lift is fantastic for strengthening the middle and lower trapezius muscles of the middle back. It's also great for improving strength and stability in external rotation (taking the shoulder away from the body) at the shoulder joint. Mastering this exercise will help to build strong and resilient shoulders. So if you're any type of athlete at all, or even a sedentary office worker who has shoulder problems, this exercise when performed correctly could be your next best friend. However, I recommend that when learning it a lot of practice with a dowel rod or broomstick is done to ensure correct elbow, scapula and thoracic positions throughout the lift.

**NB:** the elbows should remain below/under or forward of the bar when the bar is across the shoulders and they should remain in this line throughout the lift. At no stage should they end up behind the bar, as this causes internal rotation across the shoulder joint and could lead to injury.

## Key lifting technique tips
## Start position

- Feet shoulder-width apart
- The bar is in the squat position on the back of the shoulders. It should rest across the trapezius muscles behind and below

the 7th vertebrae (the one that sticks out at the bottom of the neck)

- The hands grip the bar in a wide snatch grip *(see a. snatch from hang)*. The arms should contract and pull the bar down onto the body as if to bend it across the shoulders.
- The elbows are pulled below or under the bar to align the shoulders in the correct and strong position (and not behind the bar, as previously discussed)
- Body weight, plus that of the bar, is distributed through the whole of each foot
- Lower back is arched, thoracic spine is extended and held tight, head looks forward

## 1st Dip

- The dip is initiated by flexing (bending) through the ankles, knees and hips
- Lower back remains arched, with thoracic spine extended and held tight and the head is looking forward while the elbows remain high
- The bar remains in complete contact with the shoulders

## Drive

- The ankles, knees and hips extend forcefully and the shoulders elevate whilst the elbows extend to drive the bar vertically

## 2nd Dip

- As the bar continues to travel vertically the body pulls under the bar
- The ankles, knees and hips quickly flex to pull the body under the bar whilst the elbows continue to straighten and extend

## Catch

- The upper body catches the bar; the elbows extend and the shoulders contract
- The lower body reacts simultaneously so the heels contact the ground and the knees and hips flex slightly

## Recovery

- The elbows are locked out and the bar is held overhead
- The bar is then ‘stood up’ by extending the hips and knees

With all the Olympic lifts and their variants it is extremely important to master technique. This can mean starting with a dowel rod or just the bar until good technique and range of movement are mastered in order to allow for progressive loading. Most athletes in any case will find the movements difficult and challenging enough, due to their speed of movement, without needing heavy loads.

# Getting to grips with kettlebells

**The kettlebell has been around for hundreds of years, possibly even thousands. In this chapter, Tommy Matthews examines the history of this highly effective training tool.**

## Kettlebell history

To find an exact starting point is difficult – some enthusiasts claim that kettlebells date as far back as ancient Greek times. It is thought that they were used in the ancient Olympic games, possibly in the throwing events. This speculation indicates the potential longevity of these unique training tools.

In more recent times, kettlebells became synonymous with Russia. In 1704 the word 'girya' (meaning 'kettlebell') appeared in the Russian dictionary. The men who used these implements were known as 'giveriks'. There are tales from ancient Russian times of strongmen competing against each other in local village contests. Russian people valued their strength and it was an honour to be the strongest man. The best and strongest were known as 'bogatir' – which means 'strong and honourable man'. These men were revered for their strength and it is said that they used this strength for good to fight against evil. In the early days of kettlebells in Russia there were no official competitions, just local festivals and shows where the men would demonstrate their skill, endurance and strength. This went on for many years and it was only in the 1960s that kettlebells started to be used more widely, spreading to schools and universities. Regulated competitions and official rules emerged. However, there was no national standard and although results were recorded they had little value. In the 1970s kettlebell sport was recognised by the USSR's official sports bodies. Despite this recognition there was still no established set of rules. This meant that athletes could not achieve the 'Master of Sport' accolade with kettlebells, that they could with Olympic lifting. The Master of Sport is the highest award a Russian athlete can achieve and carries with it a huge amount of honour. Eventually, in 1985 the Committee of Kettlebell Sport was set up and an official set of rules, laws, regulations and weight categories produced. The first National Kettlebell Sport Championship was held in Lipetsk in November 1985.

## Kettlebell sport

Kettlebell sport consists of three lifts: the snatch, performed with one bell; the jerk; and the long cycle clean and jerk, both of which are performed with two bells. The professionals use 32kg kettlebells, traditionally known as '2 poods' (a pood is 16kg and is a Russian measure of weight). The amateurs use 24kg kettlebells; these are known as a 'pood and a half'.

## Kettlebells around the world

The kettlebell has also been around for hundreds of years outside Russia. Records exist from the 1900s of famous strong men such as Arthur Saxon and the great Eugen Sandow lifting kettlebells. There are some fantastic images of old gyms – known as 'physical culture centres' – which show kettlebell racks lining the walls. It is an inspiration to find out about awesome old-time strong men performing some fantastic feats of strength. Any mere mortal or 21st century strong man (or woman) would quiver just thinking about.

The Milo Barbell Company in the USA was one of the first western manufacturers of barbells and in 1902 it manufactured its first kettlebell, called the 'Milo kettlebell'. It had a wooden rotating handle and an inner plate loading system and was therefore very different from the traditional kettlebell. But as with all weights with a handle outside of the mass of the weight, it had similar benefits.

Kettlebells were even used in the Highland Games. Competitors have been throwing a kettlebell-like weight above their heads and over a bar for hundreds of years (the weight throw is still performed in other athletic competitions). You can also see kettlebell inspiration today in the art of movement performed by the Shaolin Monks of China, whose key training tools included a 'padlock'. This is akin to a kettlebell, but is basically a concrete block with a handle on it.

Kettlebells have a great training history. They have been around in some form or other for centuries. In recent years they have moved into the mainstream fitness and sports training worlds and are used by the typical gym-user and athlete. Kettlebells are an awesome training tool.

## What makes the kettlebell such a great training tool?

It's all to do with the mass of the bell. The external position of the handle creates a longer lever, which is in turn further away from the user's centre of gravity. This ensures exercises become very dynamic and challenging, recruiting more muscles and importantly the 'right' muscles. If you perform a kettlebell exercise you will experience the bell (the cannonball part) moving around your hand. This creates a very different training effect from that of a dumbbell, for example – one that is not only natural, but also immensely beneficial.

## Sports training

Kettlebells are fantastic for all sporting pursuits and have great crossover to sports performance and movement. An athlete (in the widest sense) needs to have many physical qualities and the kettlebell works strength, power, speed, muscular endurance, range of movement and coordination.

## Kettlebell training reflects the dynamic nature of sport

Sport is obviously dynamic; we don't tackle an opponent on a rugby field or throw a punch in the ring slowly. Kettlebell swings, snatches and cleans are all performed dynamically, working at speeds that correspond perfectly to athletic pursuits.

As athletes we are subject to huge forces across our body and often end up in extreme positions that require strength over a huge range of movement. All kettlebell exercises are designed to focus on training the body over this full range of movement. This will achieve optimal alignment and maintain balance across the body in all of our kinetic (moving) systems.

## Key kettlebell lifts

The key kettlebell exercises are performed in the way the body is designed to stand and move. standing and moving the way the body is designed to. These are the swing, snatch, clean, military press (and variations of presses) and front. Any sports strength and conditioning programme should include a combination of these movements.

## Getting started

Choosing the right kettlebell is important as a badly designed one can cause injury and pain. Look for a kettlebell which, when sitting in the rack position, has the mass of the bell resting on the fleshy part of your forearm and not the bony prominence of the wrist. The racked position is the launch pad for the kettebell or bells for overhead presses and the landing/resting place when performing cleans and front squats, for example. Another kettlebell tip is to ensure that you can achieve a good grip in the corner of the handle and that the handle has a smooth finish.

# Weight training for rugby

**Rugby is an incredibly tough game and players are becoming increasingly powerful – which makes for some shuddering collisions. Weight training is therefore a crucial weapon in the player's training armoury. Here Tommy Matthews outlines a programme for increasing bulk and power.**

Players in all positions are getting bigger, with backs averaging 14-15 stone and forwards 16 stone-plus. The training schedules included in this article are designed to meet and develop the combative needs of the contemporary rugby player. They detail the strength training workouts that a rugby player could use to increase their power over a 6-week period pre-season and in early season. The workouts involve Olympic lifts (see chapters 6 and 7), kettlebell and other weights exercises.

## Understanding the workouts

To help you understand the methodology used within the article, take a look at these definitions:
*Posterior chain – muscles of the calves, hamstrings, buttocks and lower back
**Triple extension – muscles of the ankles, knee and hips working together to produce movement, as when jumping
**Hip extension – pushing and lifting the hips, as when lifting into a punch or tennis forehand

## Weeks 1-4
## Session 1
## Warm-up: 2 minutes on rowing machine

| Excercise | Sets | Reps | 1% rep max | Exercise benefits |
|---|---|---|---|---|
| Olympic bar bear | 3 | 5 | 25% - 45% | Mobilises all joints and prepares the body specifically for the lifting that will follow |
| Behind the neck press | 3 | 6 | 50% | Increases shoulder range of movement and strength for lifting overhead |
| Overhead squat | 3 | 6 | 25% - 40% | Increases range of movement across the body |
| Two-arm kettlebell swing | 3 | 10 | 50% | Primes the posterior chain to supply more power to the other exercises in the workout |
| Olympic bar hang snatch | 3 | 4 | 75% | Develops shoulder stability, triple extension and hip extension |
| Kettlebell snatch | 3 | 6 | 60% | Develops all body speed and power |
| Kettlebell military press | 3 | 6 | 75% | Improves overhead strength and range of movement across the shoulders |
| Olympic bar front squat | 3 | 6 | 75% | Improves range and strength across the hips and knees |

## Session 2
## Warm-up: 2 minutes on rowing machine

| Excercise | Sets | Reps | 1% rep max | Exercise benefits |
|---|---|---|---|---|
| Olympic bar bear | 3 | 5 | 25% - 40% | Mobilises all joints and prepares the body specifically for the lifting that will follow |
| Behind the neck press | 3 | 6 | 50% | Increases shoulder range of movement and strength for lifting overhead |
| Overhead squat | 3 | 6 | 25% - 40% | Increases range of movement across the body |
| Two-arm kettlebell swing | 3 | 10 | 50% | Primes the posterior chain to supply more power to the other exercises in the workout |
| Olympic bar push press | 3 | 4 | 75% | Improves power and speed and the energy transfer from the hips to the arms |
| Olympic bar hang clean | 3 | 4 | 75% | Increases speed and power across the body, focuses on triple and hip extension |
| Kettlebell one-arm clean and press | 3 | 6 and 6 | 60% | Improves overhead strength and develops range of movement |
| Olympic bar dead-lift | 3 | 6 | 75% | Great multi-muscle exercise for the posterior chain |

## Weeks 5 and 6

Weeks 5 and 6 introduce super-sets to develop the muscular endurance required of a rugby player. In a super-set, one set of an exercise is performed and then another immediately after. You would do a set of snatches with the bar taken from the knees first and then a set of kettlebell snatches (see Session 2). Super-sets usually target the same muscles across both exercises. This overloads the muscles heavily and will create optimum conditions for strength and power endurance gains.

## Session 1
## Warm-up: 2 minutes on rowing machine

| Excercise | Sets | Reps | 1% rep max | Exercise benefits |
|---|---|---|---|---|
| Olympic bar bear | 0 | 5 | 25% - 40% | Mobilises all joints and prepares the body specifically for the lifting |
| Behind the neck press | 3 | 6 | 50% | Increases shoulder range of movement and strength for lifting |
| Overhead squat | 3 | 6 | 25% - 40% | Increases range of movement across the body |
| Two-arm kettlebell swing | 2 | 10 | 50% | Primes the posterior chain to supply more power to the other exercises in the workout |
| Drop snatch | 2 | 6 | 50% | Improves speed and teaches the athlete to get under the bar quickly |
| Snatch from knees. Super-set with kettlebell snatch | 4<br>4 | 5<br>10 | Olympic snatch = 75% Kettlebell snatch = 60% | The Olympic snatch focuses on power and speed and is followed by the kettlebell snatch which brings in the endurance component |
| Dead-lift superset with kettlebell swing | 4<br>4 | 6<br>15 | Olympic deadlift = 75% Kettlebell swing = 60% | The multi muscle/joint dead-lift exercise is followed up with a dynamic swing to fire up the posterior chain |
| Front lunge with bar super-set. Kettlebell military press | 4<br>4 | 6<br>6 | Front lunge = 75% Military press = 75% | The lunge is a unilateral exercise which is important for stability and control. The military press improves strength overhead |

## Session 2

| Excercise | Sets | Reps | 1% rep max | Exercise benefits |
|---|---|---|---|---|
| Olympic bar bear | 3 | 5 | 25% - 40% | Mobilises all joints and prepares the body specifically for the lifting that will follow |
| Overhead squat | 2 | 6 | 25% - 40% | Increases range of movement across the body |
| Kettlebell swing | 2 | 10 | 50% | Primes the posterior chain to supply more power to the other exercises in the workout |
| Behind the neck press | 2 | 6 | 50% | Increases shoulder range of movement and strength for lifting overhead |
| Super-set Olympic bar clean from knees. Kettlebell clean and press | 4<br>4 | 5<br>10 | Olympic clean = 75% Kettlebell cleand and press = 60% | Increases speed and power across the body, focuses on triple and hip extension, followed by a kettlebell clean and press for muscular endurance |
| Super-set Olympic bar jerk. Kettlebell snatch | 4<br>4 | 5<br>10 | Jerk = 75% Kettlebell snatch = 60% | The jerk improves power and speed and the energy transfer from the hips to the arms whilst the kettlebell snatch adds endurance to this super-set |
| Super-set Olympic bar front squat. Stiff leg deadlift | 4<br>4 | 5<br>5 | Front squat = 75% Stiff leg deadlift = 75% | Two big compound exercises, which are both assistant exercises to the Olympic lifts. When performed in a super-set they work opposing muscle groups |

# Notes

## Notes