



# *PHYSICAL CONDITIONING FOR RUGBY – AN EVIDENCE-BASED LITERATURE REVIEW*

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*Providing coaches, referees, players, and administrators with the knowledge, skills, and leadership abilities to ensure that safety and best practice principles are incorporated into all aspects of contact rugby.*

## **INTRODUCTION**

Physical conditioning has become increasingly important in the modern game of rugby union, which has been described as “more open” and “faster”<sup>(37)</sup>. The advent of professionalism has been associated with an increase in the number of passes, tackles, rucks, tries, and ball-in-play time<sup>(54)</sup>. Empirical movement analysis data of a professional northern hemisphere rugby club during the 2004 season demonstrated the extreme physical demands amongst different playing positions<sup>(24)</sup>. For example, props covered a mean distance of 7268m, completed 29 scrums, 38 rucks and mauls, 5 tackles, 5 ball carries and lifted in 11 lineouts per match. Inside backs, although involved in far less static exertions (scrumping, mauling, rucking, lifting, etc.) covered a mean distance of 8444m per match, of which 1716m were covered by high-intensity runs (<4m.s<sup>-1</sup>)<sup>(24)</sup>. These distances and work rates are higher than what has previously been recorded<sup>(19,23,46)</sup>, and illustrate the increasing demand for physical conditioning in the modern game.

It is not only the trends of match play that are changing; the physical characteristics of players are also changing. Between 1905 and 1999, the body mass of rugby players has increased by about 2.6 kg per decade, which is greater than the secular increase in body mass<sup>(49)</sup>. Over the past three decades the body mass of elite rugby union players has accelerated<sup>(49)</sup>. There is a positive association between mean squad body mass and competitive ranking in amateur, provincial, and international rugby<sup>(49:21)</sup>. At the 1999 World Cup there was a correlation between average body mass of the squad and final ranking at the tournament<sup>(49)</sup>. The association between a heavier mass and proficiency was also observed at the schoolboy level where the average mass of the players who made the national schoolboy team was greater than the average mass of players who represented their regions but who did not make the national team<sup>(20)</sup>.

The physiological demands of rugby are complex and require all players, irrespective of position to have high levels of aerobic fitness as well as muscular strength and power, speed, and agility<sup>(49)</sup>. All these physical capacities have also been shown, similarly to an increased body mass, to be correlated with playing level and competitive rank in rugby<sup>(6,7,10,15,49)</sup>. It will thus be fair to regard these factors as important performance predictors in rugby union, and that changes in these variables should be associated with changes playing proficiency. It follows that structured resistance training programs should be designed to include various training goals, specifically: muscle hypertrophy, strength, explosive power and injury prevention<sup>(32)</sup>.

Although the strength and power training community still have to agree on the optimal program design for mass, strength and power development<sup>(9)</sup>, one concept that strength training coaches and sports scientists agree upon is that some sort of periodisation must be incorporated to promote long-term

training and performance improvements<sup>(9,35,36)</sup>. Periodisation has been defined as “the methodical planning and structure of training aimed at bringing or keeping an athlete at peak sports performance”<sup>(9)</sup>. Programs of this nature, which include structured variations in training specificity, intensity and volume, have been shown to yield greater results than programs without variation in the training stimulus<sup>(56,63)</sup>.

To reduce the risk of overtraining, adequate time for physical and mental recovery should be provided. Furthermore, to ensure that rugby players make continual gains throughout the training year, strength and conditioning specialists have traditionally prescribed programs of specific volume and intensity which vary during the off-season, pre-season, in-season and post-season (transition) phases. These phases may be referred to as mesocycles of the rugby training year<sup>(5,32,62)</sup>. Low intensity and high volume training is typically implemented during the off-season, and increased intensity with decreased load is implemented as a competitive season approaches<sup>(29,35,36,62)</sup>.

Although the emphasis of specific phases of the training year is often defined in periodised programs, variations or undulation of intensity are incorporated into microcycles, or blocks, within the mesocycles<sup>(9,35,36,62)</sup>. This strategy allows for responses from various neural and muscular components within each phase. This approach differs from a classical linear model of periodisation, which is characterised by specific training phases, each with a defined focus (e.g. muscle hypertrophy, strength, power) as well as variation of training volume and intensity<sup>(62)</sup>. Although various different models of periodisation have been proposed<sup>(9)</sup>, there is no consensus with regards to the most effective model for rugby. Classical or linear periodisation is suited to off-season and pre-season rugby training, however periodisation of in-season programs is more complex<sup>(1,8,9)</sup> and will be discussed further in the section on “in-season conditioning” below.

Research has also identified aerobic and anaerobic capacity, running speed, and agility as factors which differentiate proficiency levels in players of multiple-sprint sports such as rugby, soccer and hockey<sup>(59)</sup>. Training to develop these variables should therefore also be considered during the training year. As with resistance training, training for these variables should also be incorporated into a periodised programme. For example, there is usually a transition from less specific (aerobic) fitness conditioning of high volume and low intensity to a more specific (anaerobic) match-like high intensity and lower volume including speed, agility and quickness (SAQ) conditioning as the season progresses (i.e. representing the classical model of periodisation<sup>(62)</sup>).

Physical conditioning programs designed to increase physical capacities of players are also an effective way to reduce injuries<sup>(25,26,33,39)</sup>. For example, strength training may reduce the incidence of injuries occurring in the contact situation<sup>(25,26,39)</sup>. For this reason rugby players of all levels should be encouraged to participate in physical conditioning in preparation for training and competition<sup>(26,48)</sup>. There are common

misunderstandings about youth participating in strength training. In particular there is concern that resistance training will stunt the growth of prepubescents and adolescents, however this is unfounded and not supported by any scientific research<sup>(2,3,26)</sup>. Today numerous medical, health and professional bodies including the American College of Sports Medicine<sup>(3)</sup>, the National Strength and Conditioning Association<sup>(25)</sup>, and the American Pediatric Society<sup>(2)</sup> are endorsing the use of resistance training by young athletes to better prepare them for the rigors of sport. A proviso is that the resistance training program is properly designed and supervised and all forms of competition during training are eliminated<sup>(26, 42)</sup>. In summary, a properly designed resistance training program will not only give youth and senior rugby players a competitive advantage throughout their rugby careers, but will also reduce the risk of injuries<sup>(25,33,39,42)</sup>.

### **PHYSICAL CONDITIONING IN THE OFF-SEASON**

The emphasis of training during the off-season, also termed the preparatory period, is designed to establish a base level of conditioning and induce positive body composition changes<sup>(35,36)</sup>. The off-season is distinguished by not having the constraints of structured team practices. It is thus a particularly appropriate period for high-volume strength training. Due to the importance of muscle mass and its associations with proficiency in rugby union<sup>(21)</sup>, as well as the relationship which exists between the muscle cross sectional area and force it is able to produce<sup>(27)</sup>, a period of training designed to induce muscle hypertrophy is typically performed during this mesocycle.

The training backgrounds of the players need to be assessed before a specific strength training program is prescribed. Previous strength training history, length of recent strength training program(s), levels of intensity in previous program(s) and the extent of exercise technique experience needs to be considered when classifying players into beginners (relatively untrained), Intermediate (moderately trained) and advanced (well trained) groups for the purpose of strength training<sup>(4)</sup>. Generally players that have performed less than 2 months of strength training may be classified as beginners and if they have completed more than 2 months, but less than 12 months, they may be classified as intermediate. Players that have followed a structured resistance training program for longer than 12 months are classified as advanced<sup>(5)</sup>.

Periodised resistance training programs often incorporate general preparation at the start of a periodised program to teach exercise technique, establish a base level of conditioning, gain initial adaptation to resistance exercise stress, as well as increase the body's tolerance for more intense training during the first training cycle<sup>(51)</sup>. It has been recommended that a general preparation period of 6-8 weeks is only needed if the player is in low physical condition<sup>(35,36)</sup>. Periodised training is also not necessary to induce response until a base level of fitness has been established<sup>(14,29)</sup>. The completion of this general

preparation phase may thus see the beginner advancing to programs designed for intermediates during the remainder of the training year. Players with advanced strength training experience, and who followed a structured strength training program during the previous in-season phase and completed a short transition phase, do not need to complete the general preparation phase and may proceed straight into the phase emphasising muscle hypertrophy.

### ***Strength Training Recommendations during the off-season:***

Beginners and intermediate level players who are required to complete the general preparatory phase before proceeding to the muscle hypertrophy phase should focus on familiarising themselves with strength training. Various exercise modes of moderate (1-3 sets of 10-15 repetitions) to high volume (multiple sets of 10-15 repetitions) utilising loads of 50-70% of the one repetition maximum (1RM) should be used during the general preparatory phase to establish adequate levels of muscular endurance<sup>(4,43)</sup>. Once a satisfactory level of conditioning and skill has been reached, players may progress from the general preparation phase to the more demanding muscle hypertrophy phase of training.

It is generally accepted that higher training volumes of resistance training are associated with increases in muscle size. It is commonly advised that 6-12 repetitions using loads of 70-85% of 1RM be performed for a total of 3-5 sets per exercise<sup>(17,28)</sup>. Muscle hypertrophy may also be promoted in trained (advanced) players when training intensities (load) is increased to 80-100% of 1RM<sup>(4,31,43)</sup>. As outlined in a recent position stand of the American College of Sports Medicine<sup>(4)</sup>, specific training designed to increase muscle hypertrophy should incorporate relatively short rest periods (1-2 minutes for most lifts), and a large variety of single joint and multi-joint exercises. The frequency of training during the hypertrophy phase should be high; it has been suggested that advanced athletes perform as many as six sessions per week<sup>(4,43)</sup>.

### ***Fitness conditioning recommendations during the off-season:***

Although high volume aerobic activity is often prescribed during the off-season period, players who are trying to optimise muscle growth during the hypertrophy phase, with the goal of gaining body mass, are advised to reduce their cardiovascular training during this period<sup>(32)</sup>. This principle does not apply to larger players who are attempting to lose excess body fat.

The non-compatibility of strength and endurance training has been well documented. Kraemer et al.<sup>(39)</sup> found that a combination of strength and endurance training demonstrated only increases in the diameter of type IIA muscle fibres, where strength training alone resulted in an increase of diameter of type I, IIC, and IIA fibres. Interestingly, not all studies investigating the compatibility of strength and endurance have found similar results. It has been proposed<sup>(58)</sup> that the failure to show non-compatibility

of strength and endurance training in certain studies might be due to the inclusion of high intensity, interval-type training, rather than lower intensity high volume endurance training. It is thus recommended that fitness conditioning sessions during the hypertrophy phase should consist of short, high intensity interval based training

### **PRE-SEASON**

The emphasis of the pre-season training is typically divided into a strength phase and a power phase<sup>(32,62)</sup>. Power, which is a product of force and velocity, may be defined as the amount of work that can be performed in a specific time period<sup>(5,7)</sup>. Muscle power is an essential component of sporting performance<sup>(15,16)</sup>. In a recent investigation, measures of strength and power were able to predict playing rank between national and state rugby league players<sup>(7,10)</sup>. National league players had a 17% greater force generation in a 1RM squat, and a 12% difference in power production performing a jump squat compared to the state players<sup>(10)</sup>.

#### ***Resistance training recommendations during the strength phase of the pre-season:***

The strength phase is designed to maximise the force generation of the neuromuscular system. It is generally accepted that higher training intensities (i.e. % 1RM) result in greater strength development<sup>(28,30,50,51)</sup>. The American College of Sports Medicine<sup>(4)</sup> recommends that heavy loads of between 70% and 100% of 1RM should be used in a periodised fashion by individuals with advanced experience. Lighter intensities, 70-80% of 1RM, should be used by individuals with intermediate experience. Various loading strategies for optimal strength development have been evaluated. A meta-analysis<sup>(51)</sup> of 37 studies investigating strength responses of competitive athletes at collegiate or professional level established dose-response relationships for the optimal frequency (training sessions per muscle group per week), volume (sets per muscle group per workout) and intensity (% of 1 RM) of training. Competitive athletes have the best strength development when training at 85% of their 1RM (repetition maximum) for a total of 8 sets per muscle group, and training a muscle group 2 times per week. Another similar meta-analysis<sup>(55)</sup> investigating similar dose-responses has also been described in trained and non-trained individuals (not specifically athletes). It was established that moderately trained individuals had better responses in strength gain when training at 80% of their 1RM, performing 5 sets per muscle group and training 3 times per week. Assistance exercises during the strength phase should ideally include a low to moderate (1-3) number of sets<sup>(28)</sup>.

Commonly prescribed guidelines for optimal strength development<sup>(4,43)</sup> also include rest periods of 2-3minutes for core, multi-joint lifts and 1-2 minutes for assistance exercises, as well as an continuum of velocity (speed of the movement) for advanced and a moderate velocity for intermediate individuals. Although frequencies of up to 6 days per week are recommended for individuals with advanced

experience, it is not always practical due to the increased metabolic demand of rugby practices, which are unfortunately unavoidable during this phase of the rugby year<sup>(32)</sup>.

### ***Resistance training recommendations during the power phase of the pre-season:***

Traditional resistance training tends to only increase maximal strength at low movement velocities, rather than improving other components such as maximal power development. To improve muscle power sufficiently in rugby players, both the development of muscular strength and velocity training should be incorporated into the power phase of training<sup>(4,43)</sup>. An optimal increase in power output can be achieved by performing specific movements with lighter loads (30-60% 1RM) for 3 to 6 repetitions and maximal movement velocity<sup>(4,43)</sup>. These exercises do not have to be performed to the point of muscle failure. A multi-set (3 to 6 sets) power program integrated into a strength training program is recommended for intermediate and advanced lifters<sup>(4,43)</sup>. Olympic-type exercises such as the power clean, hang clean, hang-pull, etc. are ideally suited for this phase of training<sup>(28)</sup>. These high velocity power exercises should always be performed first in a non-fatigued state, followed by high intensity strength training<sup>(28)</sup>.

The recommended intensities prescribed for the strength training during the power phase are slightly higher than during the strength phase of training<sup>(4,43)</sup>. Players with advanced and intermediate lifting experience are recommended to perform heavy loading (85%-100% of 1RM) in order to increase the force component of the power equation (power = force X velocity). Long rest periods of 2-3 minutes for core and power lifts should also be incorporated to ensure optimal recovery between sets.

### ***Fitness conditioning recommendations during the pre-season:***

As the season approaches, there should be a shift towards greater specificity of fitness conditioning. Highly rugby-specific fitness conditioning drills may be developed from modelling the requirements of match play<sup>(57)</sup>. Recent time-motion analysis studies have reported quantity and duration of specific high intensity (sprinting, high speed runs, runs and static exertions) and low intensity (jogging, walking and standing) work activities<sup>(19,22,24)</sup>. Unfortunately such detailed analysis of each specific movement activity in isolation is not a true reflection of the metabolic demands during a match. It is a combination of these specific activities performed immediately after each other during long phases of the game which commonly cause the greatest fatigue during a match. Fitness conditioning drills should thus mimic these work periods, and in particular the work to rest ratios in order to optimise the specificity of fitness conditioning.

A shift towards greater fitness conditioning specificity should also include the introduction of speed and agility conditioning. Although it is commonly believed that genetics plays a key factor in determining speed<sup>(18)</sup>, specialised speed, agility and quickness (SAQ) conditioning, especially for less trained

individuals, may be an effective approach to improve sport performance<sup>(11,52)</sup>. Agility is commonly defined as an effective and quick coupling of braking, changing directions and accelerating again while maintaining motor control in either a vertical or horizontal direction<sup>(47)</sup>. Agility is not only important for enhancing performance in rugby, but also develops overall athleticism and reduces the risk of injury<sup>(47)</sup> and is thus a significant component of fitness conditioning. Although the majority of statements regarding the effectiveness of commercially available SAQ conditioning equipment are anecdotal and lack empirical evidence, research studies have found that structured programmed SAQ training, with or without commercially available SAQ equipment, has shown greater improvements in measures of sprint performance and agility than an active control group<sup>(11,52)</sup>. It thus shows that commercially available SAQ equipment is not necessary, and that SAQ drills are just as effective when performed without the commercially available equipment<sup>(11,52)</sup>.

## **IN-SEASON**

At this stage of the training year it may be assumed that players have made significant improvements in conditioning and that they have reached the desired levels of fitness. The focus of the in-season phase is therefore to maintain the level of conditioning which has been achieved through the increased volume of the off- and pre-season training phases. A shift towards more functional, technical and tactical training may be more important during this phase of the year. The challenge to strength and conditioning coaches is to maintain levels of fitness conditioning, as well as strength, power and body mass during long in-season periods<sup>(23)</sup>.

### ***Resistance training recommendations during the in-season:***

Traditionally in-season strength training programs are designed to follow a model of either low-volume/high intensity or some form of circuit weight training<sup>(1)</sup>. However, neither of these models are able to effectively maintain muscle mass, strength and power during the high metabolic demands imposed by concurrent practice and competition<sup>(1)</sup>. This emphasises the importance of well designed periodised program which can prevent the decrease of muscle mass that would otherwise exist as the season progresses. <sup>(1,6,8)</sup>.

Studies demonstrating effective in-season strength and power maintenance have used structured periodisation with weekly load prescriptions varying from moderate (65%) to very heavy (100%), and placed emphasis on heavy core strength exercises and training the whole body on 2 days of the week<sup>(1;6;8)</sup>. Baker et al<sup>(6)</sup> refer to their in-season model of periodisation as “wave-like”. Using this protocol they have shown improvements in measures of strength and power during a long in-season period<sup>(6;8)</sup>. When this “wave-like” model of periodisation was implemented in a highly trained professional rugby

league team, with very high metabolic demand (12 structured training sessions per week), players managed to maintain maximal strength and power during a 29 week in-season period<sup>(6)</sup>.

The in-season “wave-like” periodisation model described above typically includes short periods of higher volume training alternated with periods of higher intensity training over a 6-week period (wave)<sup>(6)</sup>. These six-week waves are repeated for the duration of the competitive season and include two resistance training sessions<sup>(6)</sup>. The first workout of the week should emphasise strength and hypertrophy maintenance, and the second workout, typically 48-72 hours later should emphasise power maintenance<sup>(6)</sup>. It is recommended that 3 sets be prescribed for core strength and power lifts and a 2-set constant load system for assistance exercises<sup>(6)</sup>. Recovery from a power training workout results in much less muscle damage<sup>(34)</sup> and therefore the subsequent recovery from these types of training sessions will be much faster. These workouts may therefore safely be prescribed later in the week without the concern of influencing match day performance.

It is also important to note that the above-mentioned study, which demonstrated no loss of strength or power during a demanding in-season period, prescribed specific time restrictions and reduced volume to their different training sessions. Conditioning was reduced to 2-3 high intensity sessions per week, each with a duration of 20-30 minutes. Skill and team practice sessions were usually carried out 3-5 times per week for approximately 60 minutes per session<sup>(6)</sup>.

### ***Fitness conditioning recommendations during the in-season:***

Fitness conditioning should be maintained through the continued use of highly specific fitness conditioning drills that mimic the demands of competition. As mentioned above, it is important to keep in-season sessions short and sharp. SAQ conditioning should also be continued into the in-season. Fitness training volume and intensity should also be periodised<sup>(6)</sup>. Coaches might choose to align moderate volume and intensity fitness training in the weeks leading up to less demanding or important matches, and low volume and high intensity training in the weeks leading up to more demanding and important matches.

South African doctors, physiotherapists, biokineticists, conditioning coaches, exercise scientists and team coaches agree that monitoring players is an essential tool in ensuring sustained performance<sup>(60)</sup>. It is recommended that players are monitored on a daily basis; volume, intensity, rate of perceived exertion and mode of training are recommended to be recorded and logged. Other valuable monitoring tools include psychological, fitness, and heart rate recovery tests<sup>(40,60)</sup>.

Optimal levels of competition performance from week to week may be ensured by coaches and medical personnel through the proper monitoring of training load, implementation of recovery strategies and

ensuring optimal recovery within every training week<sup>(38,40)</sup>. Recovery strategies recommended after training and competition include rehydration and refuelling, a structured cool down and stretch session, hydrotherapy and relaxation<sup>(38)</sup>.

### **TRANSITION/RECOVERY PHASE**

The transition phase is traditionally a phase of active rest and recuperation and commonly prescribed after the season has finished. This phase should last for between 1 and 4 weeks<sup>(62)</sup>, and should include only non-sport specific recreational activities performed at low volume and intensity. South African doctors, physiotherapists, biokineticists, conditioning coaches, exercise scientists and team coaches have recently reached consensus about “burnout” in rugby<sup>(60)</sup>. “Burnout” was defined as “a syndrome in rugby players caused by continuous exposure to a rugby environment and which is associated with underperformance and increased risk of injury and or illness”<sup>(60)</sup>. To avoid these symptoms of burnout, obligatory rest periods were recommended<sup>(60)</sup>. It was also recommended that medical assessments be performed in the week after the last match, followed by two weeks of complete rest<sup>(60)</sup>.

It is generally accepted that a previous history of injury is the greatest predictor of future injury<sup>(44,53,61)</sup>. Rugby players who were injured during a season were more likely to be injured during the following season<sup>(44,53)</sup>. It has been proposed that the increased risk of injuries in players that had incurred injuries during the previous season were more than likely due to not allowing sufficient time for injuries to heal<sup>(44)</sup>. It is thus vital that injuries that might have occurred during the season be assessed by a proficient medical professional in the transition phase. The aim of musculoskeletal screening is to assess recovery from any previous injury and to assess the presence of proven or suspected risk factors for injury in the forthcoming season<sup>(12,13)</sup>. After a full injury history has been taken, a rehabilitation program designed to rectify any weakness and to restore full function should be prescribed<sup>(12,13)</sup>.

The primary goals of this phase are thus rest, recuperation and, where applicable, rehabilitation. All these factors are of primary importance to reduce the incidence of injuries in the forthcoming season.

### **AUTHOR'S BIOGRAPHY**

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