An approach to the periodisation of training during the in-season for team sports

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Summary

A plethora of research has focused on the benefits of structuring pre-season training. However, there is a scarcity of research focusing on the potential of in-season training. This article will aim to provide the reader with evidence based and theoretical based approaches to optimising in-season strength and conditioning for team sports.

Introduction

Many team sports require different components of physical fitness, often including speed, strength, power and power endurance, as well as tactical and technical mastery whilst enduring mental stress and fatigue.[12,36] A further challenge for team sports is the extended seasons that athletes must endure, with seasons not uncommonly lasting in excess of 35 weeks in rugby union and football.[12] A well structured strength and conditioning programme has been shown to enhance muscle and bone strength, as well as eliciting improvements in muscular endurance.[13] These adaptations allow athletes to endure the repeated mechanical stress experienced during training and competition, and enables athletes to both improve performance in the mentioned characteristics and also to reduce the risk of injury.[12,24] It is also worth mentioning that due to financial difficulties in the current economic climate, it has not been uncommon to see playing squads reduced in size, causing a higher density of games to be played by the remaining players, which can reduce the opportunity for player rotation aimed at minimising cumulative fatigue.

It is clear that these factors may provide a sub optimal environment for athlete development through the in-season. However, due to the time constraints of the off and pre season, it may be necessary to explore different approaches to in-season training, that impact on the continual development of the team sports athlete. These limitations provide a challenge for the strength and conditioning practitioner in trying to impact positively on performance in season. It is therefore the aim of this article to propose a method of organising training during the in-season.

What is Periodisation?

Periodisation is a form of structuring training to achieve performance results, and involves dividing the annual training plan into phases and training units i.e. macrocycles, mesocycles, microcycles.[19,34] Periodisation aims to provide a method of integrating planning and training by manipulating training variables in appropriate sequences or combinations,[27] to create a systematic approach to optimising training. Its aim is to structure training around not only the annual training plan, but also biological adaptation to environmental stimuli[34] to create optimal athletic development in the respective sport.

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The initial concept was introduced in the mid 1900's and a number of forms of periodisation are now commonly adopted by coaches and practitioners around the world.[12] Original forms of periodisation were designed to suit the requirements of the sporting society at the time the concept was introduced. However, since its inception, sporting society has evolved and now typically includes many more competition demands in any one annual training plan. This requires that traditional views on periodisation are analysed as to whether they reflect the demands of sport today. However, a number of key concepts from the original form still need to be noted. These include the optimisation of the human biological process, as well as appropriate combination and sequencing of training variables,[27] If these are implemented in conjunction with recent developments in the understanding of physiology, they contribute to enhanced performance.[34]

The original form of periodisation proposed was developed around a 4 year Olympic cycle, aiming to peak for the Olympic games and 1 or 2 key competitions during the annual training plan, and contained preparatory, competitive and transition phases. Bondarchuk[6] termed these phases acquisition, retention and temporary loss. The preparatory phase would be subdivided into general and specific preparation, while the competitive phase was divided into pre-competitive and main competitive, while the transition phase served as active rest.[25] As strength and conditioning training has evolved, this structure has been commonly applied to many sports including that of team sports. However, this model can be misinterpreted and implemented incorrectly.

Periodisation aims to develop physical characteristics in a systematic way, by sequencing and combining training stages to positively enhance the preceding stage. This is done through a number of variables, including exercise selection to suit the demands of the training goal, the total training volume, and training intensity, which is controlled in conjunction with volume. This form of planning and application of training has been shown to be successful in its implementation, and can provide a great tool for the strength and conditioning practitioner due to its systematic implementation and utilisation of the human biological adaptive process.

Controversies Surrounding Periodisation

The common use of the classic periodisation methods introduced by Matveyev has created controversy about the way training is planned and implemented.[34] In-season resistance training is commonly performed twice a week, focussing on maintaining strength and power levels developed during the pre-season.[10,16] One of the suggested limitations of periodisation is the inability to provide multiple peak performances and/ or maintain peak performances within a season.[19] Due to the nature of modern day team sport, this could cause compromise due to the length of the competitive phase and the multiple peaks that often need to be achieved i.e. important league fixtures, cup games, international games and tournaments.

Verkhoshansky[35] criticises the implementation of a classic periodisation model, pointing out that its development was highly influenced by a few specific sports, namely swimming, weightlifting and track and field. It was also influenced by the nature of communist cycles of productivity in its paradigm. Verkhoshansky[35] also states that it is very limited in its measurement of purely volume and intensity in isolation, and that this eliminates other forms of subjective athlete regulation such as ratings of perceived technique and exertion. Verkhoshansky goes further, proposing another method of planning and implementing training, namely the Conjugate Sequence System. However, it should be noted that this takes a similar form to that of classic models. Zheljazkov[38] suggests that there is a place for classic periodisation methods and that an all round understanding of the process of adaptation is required, with knowledge that not all characteristics i.e. restoration and super compensation of metabolic, neural and motor functions, occur in a linear fashion.

Given the factors that must be considered, research has highlighted some issues with implementing in-season training programmes with the objective of maintaining gains from the preceding periods of preparation. Fleck and Kraemer,[9] and Baker[2] suggest that strength could be maintained 14-16 weeks into the competitive season, whereas contradicting research reported losses of strength 13-14 weeks into the competitive season[7,22,29] and even losses of up to 25% over a 10 week period during the in-season.[22] Nevertheless, this research highlights that this method of implementing an in-season programme elicits no strength or power development over a period that spans less than half of the competitive phase in many team sports. This common characteristic has been attributed to a loss of muscle mass which concurrently reduces strength and power, and is the consequence of a training programme not designed to regain lost muscle mass, namely low volume, high intensity training.[21] This loss in muscle mass has been attributed to the decrease in total resistance training volume that is implemented during typical in-season training programmes,[1] as well as the increased volume of energy-systems training during practice and games. These factors may also be unfavourable to performance[3] due to changes in hormonal output, differing neural patterns and fibre recruitment.[8,18]

It should, however, be noted, that the implementation of these models of periodisation could have been poorly applied, and that a loss in strength and/ or power during the competitive season[15] may be due to a poorly applied periodisation model, which does not adapt and elicit the requirements of the sports annual training plan. If periodisation is implemented correctly, it will utilise the biological adaptive process, which are required to elicit performance gains. It should also be noted that Matveyev did not intend for the model of periodisation to be rigidly applied in its purest form, and developments of the original model are produced to optimise its implementation for the annual training plans of modern day competition calendars.

Models of Periodisation

Due to the perceived limitations of the classic periodisation model and the demands of the modern day competition calendar, practitioners and researchers have sought to develop periodisation strategies further to overcome the perceived limitations[19] of the classic model. One of these methods is that of 'non-linear', also know as 'daily undulating model'. The origin is not

exactly known, however it is thought to have originated in the late 1980's where programmes were designed to accommodate the intense playing schedules of American football players, by introducing two different training emphases during training sessions within a training week.[11]

It should be noted that the term linear periodisation itself is flawed, as nothing about the human body's adaptation is linear in fashion.[34] Therefore, the term non-linear periodisation is incorrect in its concept, as all periodisation should be non-linear in fashion.[6,25] Bondarchuk[5] discusses the need for varying training loads (% 1RM) during the microcycle, in order to modulate the intensities and workloads at various levels of the training process.

The daily undulating model refers to the dramatic change of volume and intensity from one session to another, planned over the training week,[11] aiming to provide varying stimuli and supposed constant adaptation to different training loads. Fleck and Kraemer[11] suggest that each training session should target a different repetition maximum training zone, depending upon the requirements of the sport, for example within a training week of 3 sessions, zones may be performed at 4-6RM, 12-15RM and 8-10RM per set, all performed to volitional failure by the final set.

Furthermore, Fleck and Kraemer[11] suggest a development on this model to flexible non linear periodisation, whereby the training session is chosen upon athlete arrival and is determined by pre training tests in order to establish readiness to train. This method has been designed to try and accommodate intense playing schedules, and by acknowledging signs of fatigue. It aims to manipulate training session emphasis, in order to achieve optimal performance gains. Readiness to train can potentially be assessed via a range of factors including coach-athlete interactions, current injury status, body mass, hydration and fluid intake, mental and physical fatigue ratings and vertical jump power.[11] It is proposed that if an athlete is showing significant signs of fatigue in tests then the training emphasis may be changed. For example, a power session may be planned, but power tests suggest the athlete is experiencing high levels of neural fatigue. Due to the sensitivity of power output to fatigue, it is suggested that training in a fatigued state would provide sub optimal training adaptation. In this instance, the emphasis of the session could be changed to encourage optimal adaptations from the training session.[11]

Although the idea of adapting the training load based upon pre testing is sound, the application within the undulating model is flawed. It is suggested that if excessive fatigue is present, a very light day of 16-20RM, with failure occurring on the last set, should be used with short rest intervals. In reality this would compound the fatigue problem, as the high workload prescribed would create excessive fatigue. Hartmann and colleagues,[15] suggest that the increased workload, (even with reduced intensity), coupled with short rest intervals, which would result in lactic acid accumulation and increased cortisol levels, creates excessive fatigue.

Although pre training data may be valuable in determining the effect of different training stress on an individual, it is suggested that a well planned training programme can provide periods where fatigue is higher, due to overreaching, in order to achieve a positive training adaptation in the subsequent restoration period of the targeted training characteristic. This restoration can be achieved by maintaining repetition schemes and reducing the intensity of training (% 1RM), providing a more systematic management and control of fatigue. While the daily undulating model may provide a sufficient stimulus for short term training, longer term adaptation may be compromised.

Block training

Further evolutions of classic periodisation have been proposed by Issurin (Block periodisation) and Verkhoshansky (Conjugate Sequence System). Block periodisation suggests 3 components, which are termed mesocycle blocks,[19] and are titled accumulation, transmutation and realisation respectively. This design is to create concentrated means of stimuli for the elite athlete who responds more effectively to targeted abilities on training characteristics.[19,27]

In order to train the variety of training characteristics within a team sport, Issurin[19] suggests that each block should provide a level of targeted training to the stimulus within the preceding blocks. This provides consecutive developments of compatible training characteristics and infers a higher and more predictable effect. Issurin[19] proposes that the accumulation phase is allocated the longest training time, while the transmutation and realisation phase have shorter training times with the focus on event specific readiness,[19] Transmutation and realisation phase length are ultimately determined by the level and length of the accumulation phase.

Conjugate Sequence System

The Conjugate Sequence System (CSS) manipulates the strategy of overreaching in order to produce supernormal responses to training.[27] It involves periods of accumulation, followed by periods of restitution, during which supernormal responses occur. This is an advanced approach, which exploits the fitness fatigue characteristics, and focuses on developing one training characteristic during the accumulation phase.[12] Its structure involves a high volume of work for the chosen training characteristic during the accumulation phase, with maintenance type volume loads associated with other characteristics.[27] Following this, volume load is reduced markedly during the restitution phase with a moderate increase in the other training characteristics. These phases are commonly implemented in four week durations.[27] If implemented correctly, the athlete's performance in the targeted training characteristic is positively affected via the delayed training effect phenomenon.[27] This method has been shown to elicit advantages when training the advanced athlete by:

1) providing the potent training stressors required by advanced athletes for enhanced performance

2) reducing the cumulative fatigue problems associated with concurrent training

3) reducing work volumes in the long term but with an initial compromise in the short term[33,34,37]

Limitations of this system include the requirement of an environment with minimal constraints to training time,[27] and the requirement of more than two types of training characteristic, which are typically targeted in Conjugate Sequence System.[12] However, it does provide a method of training for the advanced athlete and provides superior training performance. It should

be noted that it is vital that the level of athlete is correctly determined before the implementation of this system, due to the high workload and stresses associated.

Concurrent training

Concurrent training refers to the training of multiple training characteristics at any one time during a training period. This is common in team sports, as they require multiple training characteristics in order to perform.[12] Concurrent training is highly common, especially during the in-season in team sports, when priority is focused on the sport specific training, with a greater emphasis on energy systems training.[3] Evidence suggests that energy systems training negatively contributes to strength levels when performed together[7,29] potentially due to the conflicting neural patterns, fibre recruitment, and hormonal outputs that arise from high volume energy systems training.[8,14,18] Recent work by Garcia-Pallares and colleagues[13] demonstrated how an effectively planned concurrent training programme can elicit improvements through a system of prioritising fitness components to sequentially develop in each training phase, and minimising the interference effect of simultaneous strength and endurance training. This was achieved by selecting training objectives that did not interfere with physiological adaptations at a peripheral level, allowing for the optimal development of both objectives. Furthermore, volume and intensity of resistance training was monitored and controlled with emphasis placed on order and timing of endurance and resistance training sessions.[32] It should be considered that although the training implemented by Garcia-Pallares and colleagues was concurrent in nature, the organisation of strength, power and endurance phases was done using a block model with a consideration of the interaction between these training characteristics.

It is worth noting that these models are extensions of the classic model outlined by Matveyev, and that the main difference is in the application. For example, in all forms, the annual training plan is constructed and divided into targeted outcomes based upon the competitive season. Therefore, during the general preparatory phase of the training plan, there is to be an accumulation of training loads, - an accumulation phase. The length of this phase will vary depending upon the annual plan, however it will be much longer during the pre-season when compared with the in-season. Following this, a specific preparatory phase will follow, also termed a transmutation phase, where lower training loads are experienced targeting sport specific development. This phase is determined by the length of the general preparatory or accumulation phase, in order for the delayed training adaptations to take place. The competitive phase, or realisation phase, is where training volume is decreased and the quality of training is increased.

An Approach to Periodisation for Team Sports

When implementing a periodisation model, the annual training plan of the sport should first be considered. From this, long term (macrocycle) plans can be put in place, to include preparatory, competitive and transition periods. Further to this, intermediate (mesocycle) plans can be considered, where more detail is assembled regarding elements such as the number and type of stressful competitions, the requirements for overreaching microcycles, the needs for transition/ active recovery periods etc. Short term (microcycle) planning can then take place, to determine the exact workloads required during overreaching, maintenance or recovery periods. This level of planning includes daily training routines, which take into account active recovery, as well as intra session recovery. Remembering that the microcycle can typically be 3-7 days in length and, depending upon the phase of training, the application of general preparation, accumulation, specific preparation, transmutation and competitive/ realisation phases can be adjusted accordingly.

Before implementing a periodised model, it is worth noting that rational programme design is only one element of a restoration plan. Other elements should include regenerative techniques, nutrition and sleep,[28] which are beyond the scope of this article.

By implementing this model, a systematic strategy to enhancing performance, whilst also managing fatigue, can be set up in order to provide the optimal process for adaptation to take place over the long, intermediate and short term plans. The key to implementing such a model is that it takes advantage of the biological processes of adaptation of the human body allowing performance enhancement to take place, this process should be the underlying premise of any training plan.

Therefore, keeping in mind the intense competition schedule of most team sport athletes, the microcycle and mesocycle length must be altered to accommodate for competition. It is likely that this will take place at least once every calendar week, and over an extended period of time. The strength and conditioning practitioner should identify the objectives of each mesocycle, and determine the systematic sequencing of training characteristics through each microcycle in order to create an optimal stimulus for performance enhancement over a medium to long term plan. From this, the emphasis of the microcycle can be biased towards the training characteristics, which are part of the sport and athlete plan. Although the team sport athlete has multiple training characteristics to train for, it is worth noting that when complimentary training factors are selected and sequenced appropriately, training outcomes through concurrent training can be positive. This must be done via the careful manipulation of the training variables and this should be based on an understanding of the sequencing of training characteristics required to optimise performance factors. Garci-Pallares and colleagues[13] demonstrated the importance of this planning process through work with elite level kayakers. Here, the careful planning of training sessions, included the timing, frequency, volume and intensity of training stimuli, and also considered the effects of complimentary strength, power and endurance training on performance. On a short term (microcycle) level, daily training should be planned effectively to allow optimal adaptation from the session objectives. Considerations include, the acute training stressors, the frequency of training, recovery periods and potential interference effects. This should be reproduced in the medium (mesocycle) to long term plan (macrocycle), where the sequencing of training characteristics allows for the development of multiple training characteristics through a periodised plan over a relatively short length

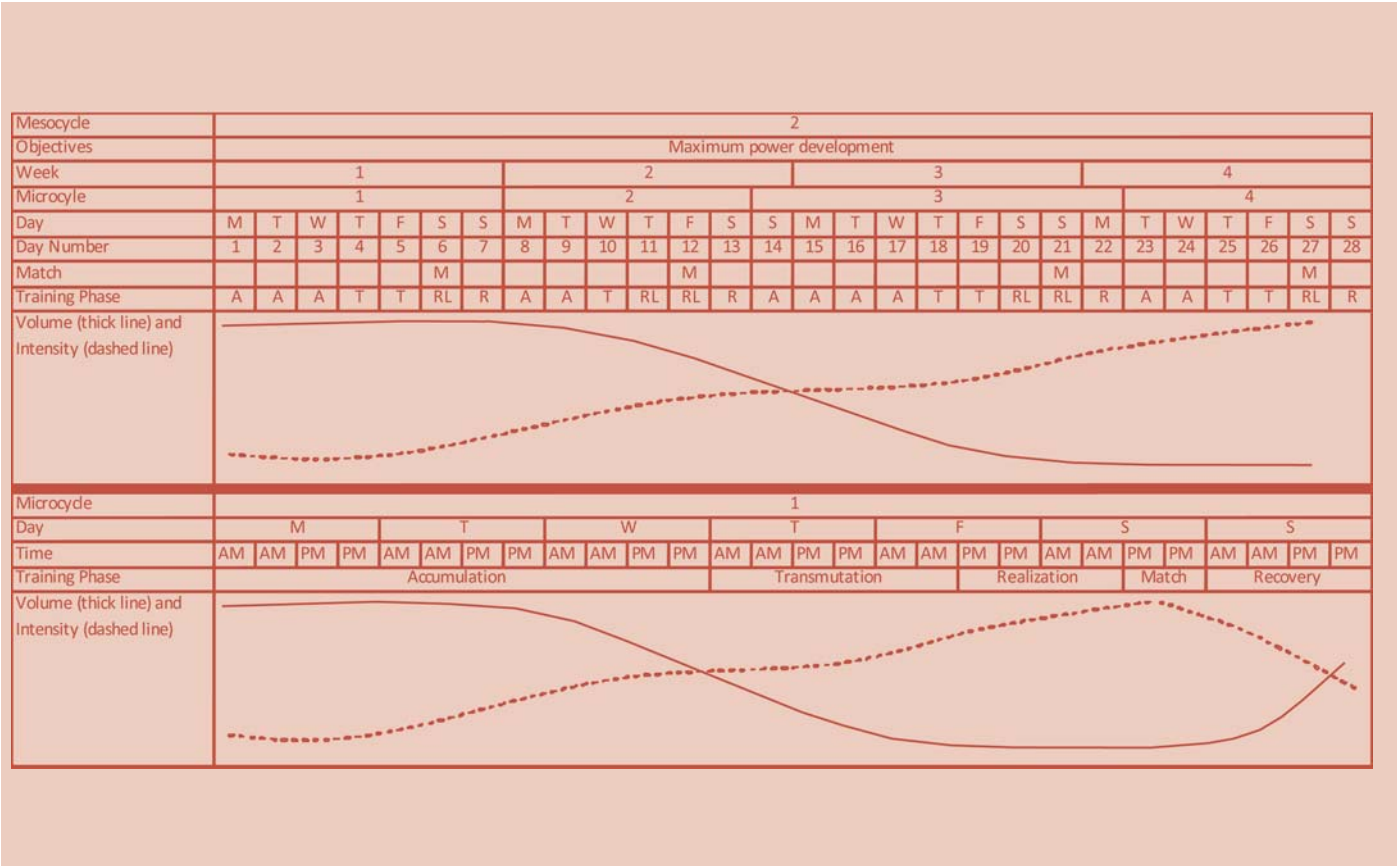

Figure 1. An example Mesocycle and Microcycle over a 4 week period of a team sport competition calendar A = Accumulation, T= Transmutation RL= Realization, M = Match, R= Recovery.

of time. However, poor planning and application of concurrent training can lead to negative effects on desired performance characteristics.[7,29]

When producing a plan for team sports, concurrent training is likely to be unavoidable during the in-season, and therefore the interference effects of training objectives must be carefully considered. An example is training for hypertrophy while simultaneously training for aerobic power. Hypertrophy training would attempt to increase protein synthesis in the muscle, causing considerable hormonal and metabolic stress at a cellular level. However, simultaneously training for aerobic power requires the muscle to increase it oxidative capacity,[23] and can reduce muscle protein synthesis due to cellular signalling mechanisms. These are two contradictory adaptations, and cause an interference effect. In determining the best approach, the strength and conditioning practitioner must consider the neuromuscular, metabolic and hormonal stress placed on the body from each competition, training session and training objective, and how these interact when performed concurrently. When all variables have been considered, the strength and conditioning practitioner can plan and implement a training plan over a long, medium and short term period with optimal effect for the sports annual training plan.

Summary

Although much resistance has been documented towards a classic model of periodisation, much of this is unwarranted due to misinterpretation of Matveyev's initial concept. Matveyev did not intend this model to be used rigidly, and evolution of the classic model has allowed for its application in many different settings, even though these evolutions are very similar to the original model. The key concepts the strength and conditioning practitioner should consider when constructing a periodised plan are:

1) Is there a systematic method of planning and application?

2) Are training characteristics planned and applied appropriately to allow for optimal adaptation?

3) Does the plan optimise the biological adaptive process of the human body through the short and long term plan?

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