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REVIEW ARTICLE

Concept of sports training periodization for better performance: A critical discussion

Kishore Mukhopadhyay

Department of Physical Education, Union Christian Training College, Berhampore, Murshidabad, West Bengal, India.

Abstract. Just like a rudderless ship in the ocean, an athlete can never succeed in international sporting events without proper planning and training periodization. Although the concept of periodization is not new, it was scientifically initiated in the 1960s, and now due to the advancement of science and technology and increment of complexity, and the number of international competitions the entire training protocol has drastically changed. The traditional concept and practice of training periodization have largely been replaced by modern goal-oriented training methodologies. The present review-based article critically discussed the different areas of sports training periodization for optimizing better sporting performance.

Keywords. Sports, performance, periodization.

Introduction

Not planning is planning failure. Sports training periodization is an art, moving forward and making more meaningful planning will require a major paradigm shift**.** it's the science that involves breaking things down into their smallest possible parts. Advances in Sports Science and coaching methodologies in the last 25 years and so, have come in leaps and bounds, logically, this led us to an adaptive approach to training planning (i.e., best optimal performance). The adaptive approach focuses on relationships and connections. "No pain, no gain." whether exercise really have to be painful, or helpful? If it is painful, then it would be a lot less enjoyable. Perhaps a better way to relay the same message would be to say that stress drives improvements. The stress previously experienced feels less stressful to the organism for the same amount of activity as a result of adaptation. The principle of adaptation refers to the process of the body getting accustomed to a particular exercise or training program through repeated exposure. As the body adapts to the stress of the new exercise or training program, the program becomes easier to perform and explains why beginning exercisers are often sore after starting a new routine, but, after doing the same exercise for weeks and months at the same intensity, the exerciser experiences little, if any, muscle soreness. This reinforces the need to constantly vary the exercise and training routine if you want to maximize your results (Principles of Adaptation to Stress, 2021).

For hundreds of years, athletes have been challenged to balance their exercise efforts with performance improvements and adequate rest. The principle of rest and recovery (or principle of recuperation) suggests that rest and recovery from the Stress of exercise must take place in proportionate amounts to avoid too much Stress. One systematic approach to rest and recovery has led exercise scientists and athletes alike to divide the progressive fitness training phases into blocks, or periods. As a result, optimal rest and recovery can be achieved without overstressing the athlete. This training principle, called periodization, is especially important to serious athletes but can be applied to most exercise

✉ K. Mukhopadhyay, e-mail: kishore.km2007@gmail.com
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plans as well. The principle of periodization suggests that training plans incorporate phases of stress followed by phases of rest.

The purpose of the study is a qualitative analysis of the sports training periodization framework based on different researchers. This framework integrates performance indicators such as training load measures, physiological constraints, and behavior-change features like goal setting and self-monitoring. It provides a training plan adopted by the athlete, and its goal adapts to the athlete's behavior. The framework for this adaptive approach is to have it be tailored periodized to individual athletes.

Depending upon the findings and discussions of other researchers the following Three hypotheses were considered for the development of the hypothesis:

H_1: Both linear and non-linear programs will show increased test results in the testing performed.

H_2: The second hypothesis was that the undulating program would produce better results than the linear program. The literature on undulating periodization suggests that it will show better results in previously trained male athletes.

H_3: The hypothesis is that athletes with more training experience will perform better when using undulating periodization than those with less training experience.

Background

Historically, the routes of training from time to time belong to Greece. According to Greek philosopher Flavius Philostratus (AD 170-245), the simplest method of training has been used since the ancient Olympic Games (Bompa, 2004).

The first attempts to make science belongings were Russian, although the information collected was much more powerful than the nature of science. Russians have enjoyed greater benefits than other countries: they have tested various models of the times with a large number of international athletes and found a lot of practical information about periodic training (Krasilshchikov, 2010).

The regular course of training, which usually lasted about two months or more, was supposed to improve the heart and lungs. Preparation of training required optimizing muscle strength and endurance and a period of about eight months. Prepared the athlete for each sporting event by emphasizing the broad practice of direct movement involved in sports (Siff & Verkhoshanky, 2000; Graham, 2002).

Russian physical education expert Lev Matveyev and Romanian sports scientist Tudor Bompa developed a periodization model. Matveyev & Bompa have been considered the fathers of modern periodization. The timing of bio motor attributes has emerged in the latest stages of periodization development. Bompa (1994) suggested that all bio motor qualities for development to reach a high level of athletic performance should go beyond periodic development.

Importance of Periodization

Some of the reasons why periodization is so important are listed below:

1. The goal of periodization is to manipulate the training stimulus to allow optimal adaptations to incur over an extended period. For the elevation of performance at the target competition, the scientific application of periodization principles is a prerequisite.

2. The dynamic variables of the exercise program design (exercise selection, stamina, repetition, rest periods, sets, and tempo) can be used in a way to gradually increase the level of difficulty, effective, but safe in achieving results.

3. Resistance training can cause two types of muscle tissue stress, metabolic stress, and mechanical stress. A well-designed designed periodization program can alternate between phases of heavyweights at low reps for mechanical stress and lighter weights at high reps for metabolic stress.

4. Rehabilitation programs typically use continuously basic progressive overloading methods primarily focused on the injured area. Training periodization is a safe way to train older adults and those in pain (Kell & Asmundson, 2009; Häkkinen et al., 1985).

5. Provides Structure: Having a pre-designed plan can help turn the "desire" of qualification into reality. Planned training programs can lead to long-term success because they help achieve one's goals that are clear, relevant, measurable, and realistic.

6. Source of motivation: Periodized training programs help athletes to push mentally with intense workouts. A structured training program that includes pre-set days, or weeks of full recovery, can be very

encouraging. It can be easy to work with intense training blocks if the athlete knows that intense workouts are goal-appropriate and temporary.

7. Prevents Fitness Plateau: Periodized training programs help athletes get through the gym and overcome the blahs of exercise. Doing the same thing over and over again is not just boring; it also eventually ensures athletes hit a fitness plateau. There is nothing more frustrating than boredom and lack of results.

8. Focus on Weakness: We all have weaknesses. Perhaps you can relate to the circumstances. Or maybe you want to improve your pulling ability. As a third athlete, my weakness is cycling. If you know you have a "weak link", adjust your exercise program from time to time to move around with a workout that emphasizes your weakness.

9. Another benefit of athletes, especially the progress of linear periodization, reduces the load at the end of the mesocycle. This can reduce the risk of injury between the training phase and the competition where the risk of injury can be high (Heard et al., 2020).

Steps of Sports Training

The Sports Training Cycle is a systematic approach to the development, delivery, and continuous improvement of a sports training program. It consists of an orderly series of stages to ensure the desired sporting outcomes.

The sports training cycle begins long before the training session is conducted and continues long after the program has been completed. In the training cycle, the emphasis is not simply on a training event itself, but also on the planning, development, and review stages.

The Training Cycle has six stages:

1. Identify Training Needs
2. Design Training
3. Develop Training
4. Deliver Training
5. Monitor the Actual performance
6. Evaluate the training Program.

Application of Periodization

The possibility to tackle emerging training loads sequentially is important through manipulating many components and related objectives depending upon individual needs. Periodization in fact has two distinct applications. Those are: (I) Periodization of training, (II) Periodization of motor qualities.

(I) Periodization of training

The fundamental aim of sports training periodization is to maximize the training effects, adjust the effects of fatigue, and prevent possible overtraining. Here emphasis must be given to on:

The theory of **load ⇒ fatigue ⇒ recovery** (Krasilshchikov, 2010).

It involves the scientific manipulation of the volume and intensity of training stimulus. Volume has been traditionally defined as the total amount of work done in a particular training session. Intensity measures vary in accordance with the nature of sports, in some cases, time and distance are factors, whereas intensity measures in % of either maximal speed or load (Krasilshchikov, 2010). In the case of resistance training, however, intensity is expressed as the percentage of an individual's maximum effort. Plisk & Stone (2003), state that the nature of training moves from extensive (high volume /low intensity) to intensive (high intensity/low volume) workloads and from general to specific tasks over a given period of time. The fluctuation between intensity and volume is related to achieving specific goal-oriented adaptations (Plisk, 2004). According to Siff (2000), classical periodization involves the division of training into basic structural units such as the training session, training day, micro-cycle (one week), mesocycle (one month), and macrocycle (e.g., one year).

(II) Periodization of motor qualities

Periodization of bio-motor qualities appeared in the later stages of Periodization development. The basic periodization principles got into the periodized planning of major motor qualities. Bompa (1994) suggested that every bio-motor quality in order to be developed up to the maximum of athletes' potential should go through periodized development.

Bio-motor abilities are the body's physiological potentials for physical performance. These potentials are practiced through various movements engaging numerous anabolic and metabolic processes, resulting in improved physical performance of the body.

Different bio-motor abilities exist, some general, others very specific.

The bio-motor abilities can be divided into two categories, as follows:

- The **foundational bio-motor abilities** include (but are not limited to): strength, endurance, speed, coordination, and flexibility.
- The **derived bio-motor abilities** include (but are not limited to): mobility, balance, power, and agility.

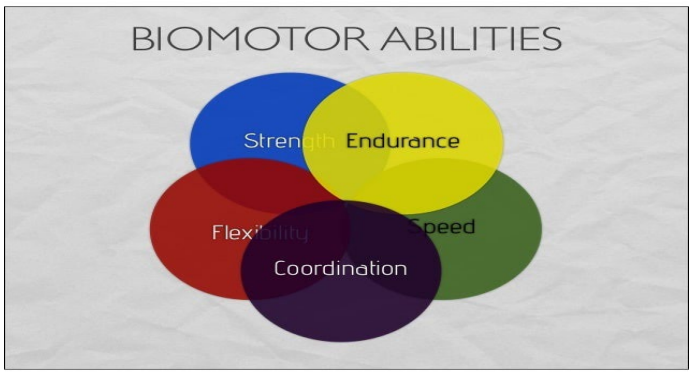

Figure 1. Bio-motor abilities (Bompa, 1994).

Training Cycles

Depending upon the training components periodization is further divided into 3 phases namely preparation, competition, and transition.

Basic periodization commonly operates with the macrocycle as the longest periodization unit. It can vary in duration from as short as 12 weeks in professional sports up to one year and is usually divided into three distinctive periods as (a) Preparatory, (b) Competitive and (c) Transitional.

(a) The duration of the preparatory period is usually the longest and is meant for the development of performance contributing factors and improvement of fitness components. It is further subdivided into the following categories: General Preparatory Period (GPP) and Specific Preparatory Period (SPP).

GPP indicates general motor qualities development and is related to the need of fitness enhancement. The GPP phase is designed to build a movement and fitness base. This is because all sports are movement and fitness based. In this phase, all aspects of fitness and skills related to specific sports are developed. All-round general fitness is developed by generally increasing the volume of training. This general fitness will allow the athletes to do the more demanding specific training that will follow without sustaining injuries (Thompson, 1991).

The SPP emphasizes sports-specific demands related to the specific fitness along with sports-specific skills It is designed to ensure the fitness that was developed in the general phase is applied directly to the specific sport. This is where sport-specific training and drills really come into play through high intensity and lower volume.

(b) The main goal of the Competitive period is the capitalize athlete's potential built-in Preparatory period. This outcome depends on participation in major competitions. The Competitive Period is traditionally divided into the 'early competitions' (or pre-competitive) and 'main competitions' sub-phases. During the pre-event phase, programs are designed to ensure there is a drastic reduction in volume while the intensity is high with full recovery. The training load should be medium volume with submaximal intensity. In the main competition phase, the availability of training time is less due to the rigor of competition and working on the sports skills. This means that only the most important exercises should be included in this phase. Training intensity is very high in the phase often 80-100%. This phase lasts the entire season (Cissik, 2001).

(c) The transitional period provides an athlete with active rest, recovery and it is meant for rehabilitation and treatment if required. In other words, a transitional period is used for controlled detraining which is one of the major training principles. The main objective of the transition period is to afford the athletes the opportunity to recover from the training load of the preparation and competition periods. Training does not stop during the transitional phase; however, it is altered in an attempt to use exercise to help athletes recover mentally and physically. Exercises during this period should be fun, new, and infrequent (2-3 times per week). It may last for three to six weeks depending on the number of peaks (Ajibua & Yakassai, 2011).

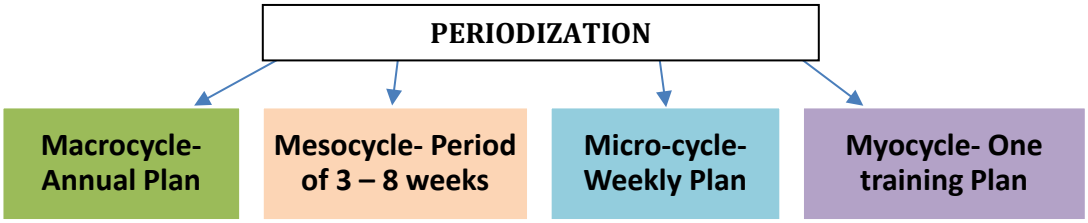

Figure 2. Types of periodization, Source: Alla & Ajibua (2012).

Designing Periodization Program

According to Ajiduah (2003), Anugweje (2003), and Cissik (2005), periodized workouts are organized into the following 4 temporal units.

Macrocycle: The *macrocycle* is the longest of the three cycles and includes all stages of a periodized training program. As macrocycles incorporate all 52 weeks of your annual plan, they exhibit a clear picture of the training regimen and allow you to facilitate long-range planning. To get faster training results, one has needed to stimulate specific, physiological adaptations. Structured training, in its most effective form, is both periodized and progressive. Throughout a macrocycle, the progressive addition of training stimulus and the necessary recovery drive aerobic adaptations must be given priority. When considering the macrocycle, there is more to it than just adding training stress. Macrocycles need to include different phases that address base fitness and then drive towards more specific fitness. By following a logical pattern, each phase ultimately leads to a particular set of adaptations upon which peak fitness is balanced. These progressive phases are the Base, Build, and Specialty phases. Table 1 represent the annual periodization plan.

Mesocycles: The *mesocycles* are typically three or four weeks in length. Two very common mesocycles consist of 21 and 28-day training blocks. A mesocycle for the intensity phase that is designed to improve your functional threshold power, or FTP (the highest average power, measured in watts, that you can sustain for one hour). This mesocycle might include three weeks of threshold intervals followed by a week of recovery.

During the competition phase, one could be able to develop a mesocycle that improves neuromuscular power, which is the ability to very high cadence for a short period of time (i.e., sprinting). This mesocycle might include four long sprint interval workouts and four short sprint interval workouts over a three-week period. One can even develop a mesocycle for the recovery stage of training. Of course, the primary goal of this mesocycle will be to rest and recuperate, but it will also include a series of easy rides designed to enhance the recovery process.

Mesocycles are four to six-week blocks within the macrocycle and are typically referred to as blocks. In a typical four-week block, the first three weeks progressively overload your body, while the fourth week focuses on recovery. Each new week within a mesocycle sees a slight increase in the overall amount of stress (TSS), while each workout sees a similar bump in the amount of work demanded. This is done by more or longer intervals (Bompa, 1999; Ronnestad et al., 2014; Manzano, 2020).

Microcycle: A microcycle cycle is essentially a week's worth of training, but a microcycle can be shorter or longer depending on the training plan/mesocycle. A batch of microcycles makes up a mesocycle. Each microcycle will have its own short-term goal and each microcycle within a mesocycle work towards the goal of the mesocycle.

For example, let's say a mesocycle is focused on increasing training load and the mesocycle is 5 weeks long:

- Microcycle 1: Base Load (75% 1RM)
- Microcycle 2: Increase Load (80% 1RM)
- Microcycle 3: Increase Load (90% 1RM)
- Microcycle 4: Peak Load (100% 1RM)
- Microcycle 5: Deload (50-60% 1RM)

Essentially, the first 4 microcycles are accumulation cycles, with each week getting harder (increasing load), and the final cycle in that mesocycle block is a deload cycle.

Table 1
Annual periodization plan.

Annual Plan (Macro Cycle)					
Phases of training	Preparatory		Competitive		Transition
Sub Phases	General preparation	Specific preparation	Precompetitive	Competitive	
Duration	16 weeks	14-16 weeks	10 weeks	6 weeks	4 weeks

The above example could also be structured in 6 weeks if the trainee felt they had another week of accumulation in them. It could also be shortened to 4 weeks in total.

Myo-Cycle: One-day training plan or a single training session is falling into this category. In the micro training plan, a single-day workout is also fallen in this cycle.

Goals of Periodization

Although the goals and phases of periodization is sports specific in nature still according to Christopher Manzano (2020) the goals or phases of periodization can be divided as follows:

- *Hypertrophy/Muscular Endurance Phase:* Hypertrophy (muscular growth) and Muscular Endurance (long duration muscular repetitive activity) occurs when exercise is performed at a low to moderate intensity ranging between 50-75% of 1 repetition maximum (of a certain exercise). Moderate to high volume ranging from 3-6 sets of 10-20 repetitions per exercise.
- *Basic Strength Phase:* Basic Strength (ability to move weight) occurs when exercising at high intensities ranging from 80-90% of your 1 repetition maximum (of a certain exercise). Volume should be moderate ranging from 3-5 sets of 4-8 repetitions per exercise.
- *Strength/Power Phase:* Strength and Power (ability to quickly and efficiently move weight) occur when exercising at a high intensity ranging from 75-95% of your 1 repetition maximum (of a certain exercise). Volume should be low ranging from 3-5 sets of 2-5 repetitions per exercise.
- *Performance Peaking Phase:* To reach peak performance, you exercise programming should be focusing on very high intensity, higher than 93% of your 1 repetition maximum with very low volume of 1-4 sets of 1-3 repetitions per exercises
- *Maintenance Phase:* If you wish to maintain any strength and muscle gains that you have accomplished, exercising at moderate intensities of 75-85% of your 1 repetition maximum and at moderate volumes of 2-4 sets of 6-8 repetitions per exercise.

Principles of Periodization

The principles of periodization as follows:

1. Periodization is a structured approach: It must be structured plan in parity with the duration of the training cycle and objective of the training plan.
2. Progressive in nature: Scope of training load adaptation must be there, and performance of the trainees should be progressive in order.
3. Organized approach: The training process must be organized properly by the coaches so that the athlete can be able to carry out training load properly.
4. Manipulative approach of doses: Scope of manipulation of volume and intensity must be there and if necessary, importance must be given to the resiliency of training programme.
5. Creative in nature: The coaches must create new ideas and thought for imparting training depending upon the interest of his athlete.
6. Peak performance oriented: Periodization should aim to exhibit the athlete's peak performance in target competition. The training load should be progressive in nature.
7. Significant relationship between volume and intensity: There should be balance relationship between volume and intensity to carry out the load dynamics in befitting manner in a particular training cycle.

8. Age Specific in nature: There should be scope of variety of activities depending upon the specificity of ages and training status.
9. Individuality: Not two athletes are alike, every individual athlete responds differently to a particular training load, so priority must be given depending upon the need and interest of an athlete.
10. Monitoring system: The performance should monitor periodically and for that proper technology-based monitoring system is important aspect for training periodization.

Types of Periodization

International sport and sport science have experienced tremendous changes, while the traditional training periodization has remained at more or less the same level as the published studies of the initial publications. As one of the most practically oriented components of theory, training periodization is intended to offer coaches basic guidelines for structuring and planning training. However, during recent decades contradictions between the traditional model of periodization and the demands of high-performance sports practice have inevitably developed. The main limitations of traditional periodization stemmed from:

(i) conflicting physiological responses produced by 'mixed' training directed at many athletic abilities,

(ii) excessive fatigue elicited by prolonged periods of multi-targeted training,

(iii) insufficient training stimulation induced by workloads of medium and low concentration typical of 'mixed' training, and

(iv) the inability to provide multi-peak performances over the season.

The attempts to overcome these limitations led to development of alternative periodization concepts. The recently developed block periodization model offers an alternative revamped approach for planning the training of high-performance athletes. Its general idea proposes the sequencing of specialized training cycles, i.e., blocks, which contain highly concentrated workloads directed to a minimal number of targeted abilities. Unlike the traditional model, in which the simultaneous development of many athletic abilities predominates, block-periodized training presupposes the consecutive development of reasonably selected target abilities (Issurin, 2010).

A. Traditional periodization

In general, periodization theory exploits the periodic changes in all human physical capacities. The cornerstones of periodization are made up by a hierarchical system of training units that are periodically repeated (Table 2). The upper level of the hierarchy includes multi-year periods like the Olympic Quadrennial cycle; the next level of the hierarchy is represented by the macrocycles, with a duration of one year or of month.

The macrocycles are divided into training periods that fulfill a key function in traditional theory as they divide the macrocycle into two major parts: the first for more generalized and preliminary work (preparatory period); the second for more event-specific work and competitions (competition period). In addition, a third and shortest period is set aside for active recovery and rehabilitation. The next two levels of the hierarchy are reserved for the mesocycles (medium-size training cycles) and microcycles (small-size training cycles), whereas the lowest rung belongs to workouts and exercises, which are the building elements of the whole training system. Traditional training periodization, which incorporated the latest know-how of the 1960s, was a breakthrough for coaching and training theory (Issurin, 2008).

The silent feature of the traditional theory is:

1) an inability to provide multi-peak performances in many competitions,

2) the drawbacks of long-lasting mixed training programs,

3) negative interactions of non- (or restrictedly) compatible workloads during traditional mixed (multi-targeted) training,

4) insufficient training stimulus (produced by mixed training) for progress in certain abilities among highly qualified athletes.

Since the 1980s multi-peak performances have become common in high-performance sports practice. This worldwide tendency can be illustrated by the highly typical examples of several outstanding track and field athletes (Table 3).

Table 2
Hierarchy of periodized training cycles (based on Matveyev, 1964; 1981).

Preparation Component	Duration	Comments
Multi-year preparation	Several years	Two basic modifications: 1) for high-level athletes – Quadrennial Olympic cycle; 2) for other categories – 2–4-year program.
Macrocycle	Several months	Sometimes identified as the annual cycle includes the preparatory, competition, and transition periods.
Mesocycle	Several weeks	Medium-size training cycle consisting of a number of microcycles.
Microcycle	Several days	Small size training cycle consisting of a number of days; frequently one week.
Workout	Several hours	A workout with a break lasting more than 40 min qualifies as two separate workouts.

Table 3
Multi-peak performances in the preparation season of world-star track and field athletes (modified from Suslov, 2001).

Athlete, disciplines	Example	Number of peaks in season	Intervals between the peaks	Total time span for competing
Marion Jones; 100-200 m running, long jump	Season 1998	10	19-22 days	200 days
Sergei Bubka; pole vault	Season 1991	7	23-43 days	265 days
Stefka Kostadinova; high jump	Season 1998	11	14-25 days	Winter -20 days, summer 135 days

Table 4
Impact of long-duration mixed training on sport-specific fitness and adaptation of high-performance athletes.

Sample	Training description	Evidence
Sub-elite swimmers (Barzdukas et al., 1990)	12 Weeks mixed specific training about 15 km/ day	Persistent increase of cortisol, CPK, and stress index; no improvement in performances
Trained road Cyclist (Soungatoulin et al., 2003)	16 weeks high intensity mixed program vs periodized intensity training	improved fitness and performance more than the traditional program
Elite rowers (Steinacker et al., 1998)	36 weeks of seasonal training	Mesocycle of intensified training lasted 2-3 weeks, approaching the critical border of overtraining
Elite Junior rowers (Bobo, 2021)	6 weeks of training prior to the world championship changing load magnitude	18 days of intensified exhaustive training of 3 h/d causes response near borderline of adaptation
Trained Athletes (Lehman et al., 1993)	6 weeks mix monotonous and intensified training 6 d/w lasting 40-60 min/d.	3 weeks produce enhanced fitness but a further 3 weeks cause deterioration or stagnation

The drawbacks of prolonged mixed training programs have been noted for a long time; however, most of the scientific evidence of this training insufficiency has been reported during the last two decades (Table 4). The outcomes of the above research projects highlight typical negative consequences of prolonged mixed training, namely:

1. excessive fatigue accumulation as indicated by persistently increased excretion of stress hormones and creatine phosphokinase (Barzdukas et al., 1990;

Lehman et al, 1997; Stone et al., 1991; Hooper et al., 1995).

2. intensive prolonged mixed training yields remarkable results initially but stagnation or low improvement rate later on (Sharobajko, 1984; Zemliakov, 1991; Lehman et al., 1993).

3. intensive exhaustive training lasting three-four weeks causes a pronounced stress response when athletes approach the upper limits of their biological adaptation (Lehman et al, 1997; Steinacker et al., 1998; Steinacker et al., 2000); prolongations of such a program dramatically increase the risk of overtraining.

B. Block periodization

The block periodization (BP) training approach is an efficient and efficacious alternative to traditional training design. The basic premises of BP are:

- The primary premise of BP is the employment of highly concentrated training workload phases (periodization blocks) and the resulting after and residual effects.
- The blocks must be sequenced in a logical order to benefit from the residual effects.
- The BP approach has been proposed in 2 variations: the concentrated unidirectional design (single goal or factor) and multiple factors.

Block periodization is not only for race preparation but is also a great training tool during the offseason or for those who do not race but just want to improve. If you are seeking to improve as an athlete, change your primary focus within each block and continually increase the workload. The observed problems associated with the traditional periodization paradigm, Verkoshansky (Verkhoshansky, 1979; 1988) created the concept of a concentrated load (CL) and developed the conjugated successive system of training for athletes, again focusing on nonteam sports. This concept laid the foundation for BP. A CL is a "block" of unidirectional training that emphasizes a single or very few related characteristics, such as strength and rate of force development (Verkhoshansky, 1979; 1988). Unidirectional refers to the de-emphasis of fitness characteristics other than the training of the primary fitness characteristic. Issurin (2016) noted that residual effects (effects lasting several weeks after the CL was completed) persisted and could potentiate the next phase (block) of training. Residual effects must be considered within the context of "reversibility." As training load is reduced or removed, improved fitness characteristics return toward baseline (reversal), however, there are always residual effects of improved fitness characteristics that persist for some period of time. The main characteristics of the three types of blocks-mesocycles are shown in Table 5.

A detailed description of block periodization is shown in Table 6.

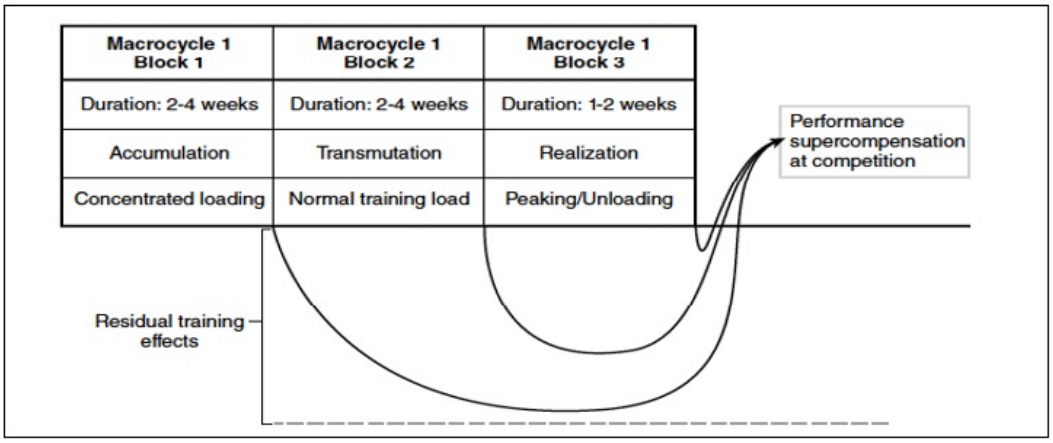

Figure 3. Model of Block Periodization (Bobo, 2021).

Table 5
Main characteristics of the three types of blocks-mesocycles (Modified from Issurin, 2010).

Characteristics	Accumulation phase	Transmutation phase	Realization phase
Targeted motor and technical abilities	Basic abilities: Aerobic endurance Basic coordination General strength	Sport-specific abilities: Strength endurance Power Special endurance Anaerobic threshold	Tapering: Modelled performance Speed Tactics Mental preparation
Recovery	Periods of recovery needed for adaptation. No accumulation of fatigue	Full recovery is not possible, fatigue accumulates	Decrease in training load to ensure full recovery at the end of the cycle
Training load	Average High volume, reduced intensity.	Training load Reduced volume, increased intensity	Average Low volume, intensity high.
Testing battery	Tests for basic abilities. Discipline-specific if possible	Tests for sport-specific abilities	Tests for speed, event strategy

Table 6
Description of Workload in Block Periodization (Lorenz & Scot, 2015).

Phase	Objective	Intensity	Sets X Reps	Duration
General capacity/ Tissue healing	Build work capacity & general fitness, promote healing	Zone 1 or lower end of zone 2 at 6-7 RPE	2-3 Sets X 10 – 15 reps, in between rest ~2 min.	2-4 weeks
Accumulation	Continue to build work capacity with more specific emphasis (Hypertrophy)	Zone-2 Strength, Zone-1 Power	Core exercises 8-12 reps for 25-35 total reps.	3-4 weeks
Transmutation	Specific emphasis on specialized works. Maintain aerobic base	Zone-3 Strength and Zone-2/3 Power	4-6 reps for 12-24 total reps.	2-4 weeks
Realization	Emphasizing Power and Maximum Strength	Zone-4 Strength and Power	1-4 reps for 8-15 total reps	2 weeks
Restoration	Choose a variety of Exercises < 50% of 1RPM, Total workout with high repetitions and light loads.			

C. Non-linear/undulating periodization

The other main model is the non-linear or "undulating" periodization model, first proposed by Poliquin (1988). While undulating periodization has been used, the term "non-linear" has become more favorable. Nonlinear periodization (NP) is based on the concept that volume and load are altered more frequently (daily, weekly, biweekly) in order to allow the neuromuscular system longer periods of recovery as lighter loads are performed more often (Lorenz et al., 2010). In the NP model, there are more frequent changes in stimuli. These more frequent changes may be highly conducive to strength gains (Poliquin, 1988; Lorenz et al., 2010).

There are many potential advantages to the NP approach, although no definitive conclusions can be made at this time. First of all, the weekly fluctuations in training loads may lead to better neuromuscular adaptations compared to the LP approach, as loads are more unpredictable. Secondly, the NP program accounts for the need for modifications in the training program based on an athlete's recovery from competition or from a previous workout/training session.

Comparison of Different Periodization

The goal of a periodized program is to optimize the principle of overload, the process by which the neuromuscular systems adapt to unaccustomed load or stressors (Ratamess et al., 2009; Poliquin, 1988).

Cissik et al. (2008) believe that the model of linear periodization will help develop the athletes, so they are peaking for their competition season. Monteiro et al. (2009) explain that the varying loads used in linear periodization will continue to overload the training stimuli and in return cause greater training gains. Another popular belief is the higher total volumes that are usually associated with the linear model can lead to large gains in younger or untrained athletes (Baker et al., 1994).

One concern with linear progressions is that in later phases where high intensities are continuously performed from day to day and week to week, overtraining of athletes could become problematic. Just by attempting near-maximal weights in as little as two weeks, an athlete can show signs of overtraining (Bradley-Popovich & Haff, 2001). A counterargument in response to this concern is that there are often de-loading weeks where volume and intensity are decreased.

On the other hand, undulating periodization has different phases, but typically utilizes more microcycles. There are high-volume phases that are known as accumulation and high-intensity phases known as intensification (Poliquin, 1988). The idea behind changing the volume and intensity on a weekly or daily basis is that these changes not only keep the training stimulus "sensitive", but also don't allow the athlete to continue training at the high intensity they did in the final phase as in linear progression. This can better prevent overtraining syndrome (Bradley-Popovich & Haff, 2001). Buford et al. (2007) also suggest that this model is better at preventing overtraining because it often causes the neuromuscular system to rest during high-intensity work.

Rhea et al. (2002) conducted a study comparing linear versus daily ups and down periodization (DUP) and concluded that the DUP model showed a greater percentage increase than the linear program (Rhea, et.al., 2002). Although this study shows that the DUP model has significant gains over the linear form, it is rather limited because the volume is equalized.

However, Hoffman et al. (2009) showed that both the linear program and the DUP program performed better than the program without periodization. Another study of Simão et al. (1012) indicates 12-week training period, the implementation of an NLP program may result in superior maximal strength and MT improvements compared with the classical LP model.

There are three major criticisms of linear periodization systems, such as:

- Many athletes and scientists are believed that the sudden introduction of high-intensity running after a strictly low-intensity base phase carries a high risk of injury.
- A second criticism of linear periodization systems is that the various important aspects of running fitness are not developed "harmoniously".
- Finally, linear periodization systems are also criticized for requiring months of buildup for a rather brief opportunity to race at the very end.

In nonlinear periodization, because high-intensity training never ceases, there is a greater risk of overtraining, and because there is not much distinction between training phases, it can be difficult to time a peak accurately (Simão et al., 1012).

Different training methods work best for different athletes. No specific periodization is fixed for anyone else. A linear periodizing system, such as the Lydiard system, or a non-linear system, such as Martin and Coe's multi-tempo method, are clearly considered to be more suitable for each athlete. It is believed that either linear periodization systems such as Lydiard's or nonlinear systems such as Martin and Coe's multi-pace method are clearly better for every athlete (Fitzgerald, 2021).

Conclusion

Individualized sports-specific periodization is the major concern for exhibiting the best performance in the modern sporting world. Depending upon the various methods of periodization modern approach of block periodization is a major concern in solving the problems associated with the traditional periodization paradigm. At this time, the research on periodization is limited, not only in the rehabilitation literature but also in strength and conditioning. BP is an alternative sports training concept in the context of most biological

mechanisms of human adaptation. These mechanisms include homeostatic regulation and general adaptation. Strained metabolic and hormonal background aggravates and suppresses homeostatic regulation and disrupts the training effect of exercises for basic athletic abilities. Dramatic consequences of this deterioration can be found especially later in the season of elite and sub-elite athletes, namely: a decline of maximal aerobic power and anaerobic threshold (Mero et al., 1993; Koutedakis et al., 1992; Michalski et al., 1988; Simoes et al., 1998), a decrease of maximal strength, (Zemliakov, 1991; Koutedakis et al., 1993; Hagerman & Staron, 1983; Hoffman et al., 1991) performance impairment, (Barzdukas et al., 1990) and incidences of overtraining (Lehman et al., 1997; Stone et al., 1991; Hooper et al., 1995). In contrast, BP proposes a separation of workloads producing conflicting physiological responses and thus facilitates a situation in which each mesocycle block employs its proper combination of training loads and exploits the appropriate mode of biological adaptation.

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