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REVIEW ARTICLE

Benefits and Limitations of Block Periodized Training Approaches to Athletes' Preparation: A Review

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Abstract The present review introduces innovative concepts of training periodization and summarizes a large body of findings characterizing their potential benefits and possible limitations. Evidence-based analysis of the traditional periodization model led to elaboration of alternative versions of athletic preparation. These alternative versions postulated the superiority of training programs with a high concentration of selected workloads compared with traditionally designed plans directed at the concurrent development of many athletic abilities at low/medium workload concentration. The training cycles of highly concentrated specialized workloads were coined "training blocks" by experts and practitioners; correspondingly, the alternative versions were termed "block periodized (BP) preparation systems" by their presenters. Ultimately, two BP training models were proposed: a concentrated unidirectional training model (CU) and a multi-targeted BP approach to athletes' preparation. The first innovative version postulated administration of highly concentrated training means for enhancement of one leading fitness component, whereas the second version proposed the development of many targeted abilities within sequenced block mesocycles containing a minimal number of compatible training modalities. Both versions differ in their methodological background, duration and content of training blocks, possibilities of providing multi-peak performances, and applicability to various sports. In recent decades, many studies have evaluated the effects of both BP training versions in different sports. Examination of the training effects producing by the CU model in combat and team sports has found significant gains in various fitness estimates but not in sport-specific performances. Similarly, utilization of a CU program by elite swimmers did not lead to substantial enhancement of their peak performances. In contrast, studies of multi-targeted BP training programs have revealed their distinct superiority compared with traditional preparation in endurance, team, and dual sports, and strength/power training and recreational athletes (28 studies). It is suggested that the CU training strategy suits athletic disciplines demanding one fitness component like explosive strength in jumping performances. Unlike this limitation, the multi-targeted BP system prompted a beneficial increase of specific preparedness in sports and disciplines in which peak performances require the application of many targeted athletic abilities.

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Key Points

The block periodized training approach is an efficient alternative to traditional training design.

The principal premise of block periodized programs is the employment of highly concentrated training workloads.

The block periodized approach has been proposed in two variations: the concentrated unidirectional design and the multi-targeted version of the block training design.

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1 Introduction

Periodized training is considered the salient planning strategy for athlete preparation. Several important publications have greatly affected how such training is viewed and understood today. Almost 100 years have passed since publication of the first book devoted to Olympic sport that shed light on periodization training [1], 50 years have passed since publication of the book that was correctly recognized as setting guidelines for training periodization [2], and 30 years have passed since the earliest publications of alternatives to the traditional periodization approach were introduced [3, 4]. Unlike the traditional concept, these alternative versions proposed a high concentration of training means within appropriate preparation cycles. At that time, many coaches from various sports and different countries started to utilize the term ‘training block’ to characterize training intervals with a high concentration of specialized workloads. Following this logic, the proposed alternative concepts of athlete preparation were called ‘block periodization’ (BP) training systems. This term and approach has become particularly popular in recent decades with the publication of a relatively large number of analytical and research papers. The general attitude of the professional audience to these innovative approaches can be characterized as interested, curious, and oriented for practical implications. Since BP training is still relatively new, many contradictory and even erroneous meanings can be found in internet databases and coaching forums. These misconceptions among some professionals and the appearance of new findings from well controlled studies spurred the present review, which is intended to highlight the evidence-based benefits of BP programs and indicate their possible limitations.

Like ideas that develop in many fields, BP has taken on different forms according to the positions and experiences of those who presented them. The general premise of BP—a high concentration of specialized workloads for more pronounced training stimulation—is not the monopoly of one author. The idea was proposed and implemented by different researchers at approximately the same time. Since the mid-1980s, two basic versions of BP planning and implementation have existed simultaneously: the concentrated unidirectional (CU) training model [4, 5], and the multi-targeted BP approach to athlete preparation [3, 6–8].

Both versions are examined here with regard to their essential features, scientific background, and available research findings. For this purpose, a large number of scientific publications were drawn from peer-reviewed journals using Google Scholar search engines and the PubMed, MEDLINE, and SIRC electronic databases. Additional sources included scientific reports, PhD and Master’s theses, professional books, and proceedings of international conferences. With few exceptions, the selected sources were published during the last 3 decades. The review necessarily utilizes 11 sources published in Russian, as the BP approach was initially introduced in the former USSR.

2 The Concentrated Unidirectional (CU) Training Model

The coaching concept and elucidation of the CU training model was proposed by Professor Verkhoshansky based on his findings in long-term studies of speed–strength training, mostly in the jumping disciplines [4, 5]. The vast number of studies and observations allowed him to reveal the phasic changes of speed–strength variables following administration of highly concentrated strength/power workloads. He reasonably proposed that a high concentration of training workloads directed at developing the dominant targeted ability is better than the traditional design, where training stimulation focuses on different targets. His later publications introduced a theoretical background for his proposed approach, including its clarification and possible implementation in various sports.

2.1 Theoretical Background

The important premise of the theoretical background is the phasic alterations of training capacity and athletic performances that follow execution of relatively prolonged blocks of highly concentrated strength/power workloads. These alterations tend towards a remarkable decline and subsequent enhancement of speed/strength variables with postponed achievement of peak performance in the targeted discipline [4, 5]. The author postulated that such phasic alterations have a deterministic character and named this phenomenon the “long-term lagging training effect” (LLTE) [9, 10]. Its essential characteristics are shown in Table 1.

Considering the methodological concept of LLTE, a number of questionable positions should be emphasized and commented upon. Indeed, LLTE generally corresponds to the delayed training effect phenomenon [11]. However, the persistent decrease of relevant fitness variables during the 6- to 12-week period raises a reasonable question: How is it possible to differentiate this decline from overtraining-associated motor responses? Although the author claims that greater fitness decline produces its greater subsequent increase, there are no objective findings highlighting physiological adaptations underlying these phasic alterations. Similarly, the persistent progression of previously suppressed fitness estimates requires appropriate

Table 1 Characterization of long-term lagging training effect (based on Verkhoshansky [9, 10])

Main characteristics	Block 'A'	Block 'B'
Content of training workloads	Highly concentrated unidirectional program focused on strength/power exercises	Execution of properly selected sport-specific exercises with appropriate recovery
Workload volume	High. Individual adjustment based on previous experience	Reduction following need for recovery
Workload intensity	Medium. Concentrated workloads themselves intensify preparation	Gradually increases
Block duration	6–12 weeks	6–12 weeks; the same as block 'A'
Contribution of technical work	Execution of technical drills not advised	Purposeful execution of technical exercises
Trend of speed/strength estimates	Gradual decrease during the period	Gradual increase until higher than previous level

explanations in neuromuscular, hormonal, and metabolic terms. This evidence-based support is absent. In addition, the author did not recommend the performance of technical routines during prolonged block 'A'. Perhaps such planning is associated with residual fatigue accumulated during this voluminous training phase. In any case, such a moratorium on technical drills sport contradicts today's reality in high-performance sport.

The further explanation of CU training system presupposes a load sequencing that progressed from power/strength development (2–3 months) to more specialized sport-specific improvement (2 months) and event-specific technique enhancement with competitive performance practice (3–5 weeks). The author called this three-block sequence (i.e., blocks 'A', 'B', and 'C') the "big adaptation cycle", the duration of which was 22–26 weeks [10, 12].

The CU training system was proposed as an innovative approach for high-performance athletes, when load regulation is associated not only with volume/intensity interplay but, in particular, with proper structuring of the training program content. In fact the 'three block unity' offers a reasonable and realistic framework for annual planning. However, their time span allows the inclusion of two 'big adaptation cycles' per year, which correspondingly means implementation of a two-peak annual design. Viewed in this light, this innovative version has no advantage over traditional planning, because it does not allow the multi-peak annual design demanded for effective preparation of high-performance athletes.

2.2 Evidence of Studies Evaluating the CU Training Model

Over recent decades, a number of studies have been conducted around the world aimed at evaluating the effect of CU training in different sports (Table 2).

The first study listed in Table 2 presented a comparison of traditional and BP training models for shootboxers [13]. The CU program consisted of sequenced blocks intended to develop endurance, maximal strength, explosive strength, technique and rapidity, and, finally, specific endurance. Statistical treatment revealed the superiority of the BP group only in specific endurance, the development of which was completed towards the last part of the program. The authors concluded that the BP training model was only partially applicable to the needs of the athletes under study.

The next three studies were conducted with elite basketball, handball, and soccer players [14–16] and included sequenced training blocks of highly CU workloads. In all these cases, prolonged BP programs resulted in significant enhancement of various fitness estimates; however, the researchers did not report the effects of the programs on team practice and competitive activities. Unfortunately, the investigators appeared to not consider the possible impact of innovative training interventions on the professional mastery of elite athletes.

The experiment with elite swimmers revealed remarkable gains in specific strength and anaerobic capacity, whereas swimming performance was enhanced in only two of the three subjects—a relatively small sample to begin with [17].

It is worth noting that all the above studies used adequate research methods and appropriate statistical treatment. Nevertheless, the study outcomes do not provide sufficient evidence for further implementation of the CU BP approach in preparing high-performance athletes in combat, team sports, and swimming.

2.3 Comments

The coaching concept and planning approach associated with the CU training model looks promising for sport science and for practice. Its potential benefits lie in increased training stimulation and the novelty of the general approach, important elements for high-performance athletes. It is noteworthy that the methodological

Table 2 Effects of concentrated unidirectional bloc periodization training programs

Study	Study design	Effects
Villani and Gesuale [13]	BP program (5 blocks focused on selected abilities) vs. T mixed program; 15 weeks, 20 RL shootboxers	Superiority of BP group in specific endurance; superiority of T group in hit rapidity and endurance
Moreira et al. [14]	BP program (3 blocks: strength/power, speed/intensity, game practice); 2 cycles 23 and 19 weeks, 8 EM basketball players	Significant gains in jump performance; data on game activities not reported
de Souza et al. [15]	BP program (4 blocks: strength, power, speed, techno-tactical practice); 16 weeks, 11 EM handball players	Significant gains in jump performances, agility, anaerobic power, and VO_{2max}; data on game activities not reported
Campeiz and de Oliveira [16]	Seasonal program including block of highly concentrated strength/power training; 16 EM soccer players	Significant gains of anaerobic power, decreased body fat. No reports on game activities
da Silva Marinho [17]	BP program (3 blocks: strength, power, and speed/technique); 18 weeks, 3 EM swimmers	Large increase of maximum force and anaerobic capacity; 100 m performance enhanced by 2 swimmers by 0.63 and 0.7 %. No gain in one swimmer

BP block periodized, *E* elite, *M* male, *RL* regional level, *T* traditional, VO_{2max} maximum oxygen uptake

background elaborated by Professor Verkhoshansky is based on findings from his long-term studies and experiences in speed–strength disciplines, particularly in jumping performances. Apparently, his efforts to disseminate this innovative approach to other sports entail some serious restrictions, which require appropriate consideration.

First, the general concept of CU training postulates the selective development of one leading capability and thus is basically suited to athletic disciplines demanding a small number of targeted abilities. In athletic disciplines requiring many targeted abilities, the unidirectional approach does not offer the conditions for balanced training stimulation of all sport-specific components that determine athletic preparedness and peak-performance.

Second, the methodological concept of LLTE properly describes sequencing stages with highly concentrated strength/power workloads and event-specific strength and recovery stages. However, when a strength/power block is followed by a block of aerobic endurance and/or techno-tactical enhancement, the maintenance of increased strength abilities firmly depends on the duration of their residual training effect, which lasts about 1 month [18]. If the second block duration is 6–12 weeks, athletes will experience a dramatic decrease in their strength potential. Residual training effects were not taken into account and were never mentioned in any of Professor Verkhoshansky's publications.

Third, the inability to participate successfully in many seasonal competitions is a serious restriction of the traditional training system. However, the CU training model does not offer a means of overcoming this limitation. It proposes sequencing for two 'big adaptation cycles' per year, meaning two peak performance phases.

Fourth, studies evaluating the effects of CU training designs did not provide evidence supporting their practical application in sports that require high-level performance of many targeted abilities. These outcomes are not in agreement with previously published data that display the pronounced effects of unidirectional training of athletes mostly in the jumping disciplines [4, 19].

It is worth suggesting that all these circumstances restrict the application and implementation of CU training programs in preparing athletes for competitive activities requiring a number of targeted abilities. Nevertheless, this training approach remains viable for disciplines in which peak performance is strongly determined by a limited number of event-specific features.

3 Multi-Targeted Block Periodized (BP) Training Models

In the early 1980s, the general idea of enhancing training stimulation of high-performance athletes by higher concentrations of appropriate training means was adopted and implemented by many prominent coaches and researchers. The problem was how to obtain high concentrations of efficient workloads to develop many abilities that determine peak performance. The proposed solution is based on consecutive development but not simultaneous development of targeted abilities by properly sequencing specialized training blocks. This training approach was implemented in the preparation of elite athletes in different sports and led to outstanding achievements [3, 6–8]. Unlike the CU training model, the BP concept is aimed at the enhancement of many targeted abilities contributing to success in certain sports. The term 'multi-targeted BP approach' emphasizes difference from the unidirectional training model. The essence and principal positions of the multi-targeted BP version are presented below.

3.1 Methodological Determinants of the Multi-Targeted BP Training System

The appearance of an alternative BP system was necessitated by the serious limitations of traditional preparation system. These deficiencies occurred as distinct preconditions for the reformation and elaboration of a multi-targeted block system (Table 3).

A critical interpretation of the shortcomings listed in Table 3 and the findings of long-term follow-up studies facilitated the creation of an alternative BP training system. These are its essence, general concepts, and principles:

- The main structural unit of BP preparation is a training block lasting 2–4 weeks, which corresponds to a single mesocycle. Each block mesocycle includes highly concentrated workloads directed at a minimal number of training modalities.
- Unlike traditional 'mixed' programs directed at concurrent work on many training modalities, the BP training system proposes the consecutive development of targeted abilities aiming at optimal interaction and superposition among them.
- The block mesocycle taxonomy presupposes their categorization into three types: 'accumulation', which focuses on basic abilities, e.g., aerobic endurance, muscle strength, and general coordination; 'transmutation', which focuses on sport-specific abilities, e.g., high-intensity anaerobic workloads, strength endurance, and proper technique; and 'realization', which focuses on recovery and peaking towards competition or trials.
- Each block mesocycle operates with compatible training modalities to avoid conflicting physiological responses; non-compatible training modalities are separated into different block mesocycles.
- Together, the three block mesocycles specified above form a training stage that lasts about 2 months and ends with participation in a competition or trial.
- The annual cycle consists of training stages that can vary in number from five to seven depending on the quantity and timing of targeted competitions.

The notable methodological factor that contributes to this BP version is biological differentiation between the block mesocycles entailing extensive volume (accumulation) and those entailing intensive stress (transmutation). In addition, residual training effects, meaning 'the retention of changes in body state and motor abilities after cessation of a training program beyond a given time span' [11, 18, 20], are of primary importance when the development of several athletic abilities occurs consecutively. The superposition of training residuals following sequenced block mesocycles makes it possible to obtain the optimal interplay of many fitness components and attain the best conditions for peak performance [21].

The biological background of the proposed block mesocycles exploits fundamental theories of human adaptation, specifically: 'homeostatic regulation', which tends to protect stability of the most rigid biological constants [22, 23], and 'stress adaptation', which underlies the mobilization of extraordinary human resources [24]. Developing basic athletic abilities, which are the targets in accumulation mesocycle (i.e., aerobic endurance, muscle strength, and general coordination) is subordinated by homeostatic mechanisms. Contrary to that, the execution of a highly intensive glycolytic program of transmutation mesocycle demands and triggers stress reactions [19]. Concurrent execution of exercises for basic abilities and sport-specific intense fitness components (as in the traditional planning approach) evokes conflicting physiological reactions: the stronger stress mechanism suppresses homeostatic regulation and has a deleterious effect on training directed at developing basic athletic abilities [19, 25]. This effect provides a robust foundation for separating basic voluminous programs and intensive sport-specific training programs into their own appropriate block mesocycles.

Table 3 Factors determining the need for a multi-targeted block periodized approach

Factors and preconditions	Comments
Low effectiveness of concurrent development of many physical and technical athletic abilities	'Mixed' training programs did not provide sufficient training stimulation for high-performance athletes
Execution of extremely high training workloads that tend to continue to increase	Insufficiency of training stimulation force increases in training workloads and incidents of overtraining
Frequent incidents of overtraining and increased residual fatigue in athletes	Excessive workloads have a detrimental impact on training adaptations and health
Conflicting physiological responses when one task destroys the effect of another one	'Mixed' training programs include non-compatible training modalities
Inability to take part in many competitions during the season	Traditional periodization presupposes one-, two, and three-peak seasonal design
Dissemination of harmful pharmacological programs that facilitated training responses	At that time (1970–1980s) such pharmacological interventions were not controlled

3.2 Applications of Multi-Targeted BP Programs in Different Sports

The earliest successful attempts to implement multi-targeted BP programs in the preparation of high-performance athletes were made in canoe–kayak paddling [3], track and field (hammer throw) [6], and swimming [7, 8]. In all these cases, the authors independently elaborated training systems where specialized training blocks were consecutively directed at the development of generalized (basic) abilities, sport-specific fitness components, and peaking towards competition. These studies and experiences led to valuable outcomes: a number of gold medals were earned in the Olympic Games of 1988 and 1992 [26]. Since then, a large number of studies evaluating the effects of BP training programs have been conducted in various sports; their outcomes are reviewed below.

3.2.1 Outcomes of Studies Conducted in Endurance Sports

The largest number of studies with the application of BP training programs was executed in endurance sports, and the most representative publications are listed in Table 4.

Three studies listed in Table 4 present data of well-documented experiments with national teams of different countries: USSR, Spain, and Romania [27, 28, 33]. In all these cases, comparisons of BP programs with traditionally designed versions revealed evidence-based superiority of the innovative approach supported by athletes' achievements in the highest levels of competition. The other studies showed higher effectiveness of endurance programs interspersed with short-term blocks (7–11 days) of high-intensity interval training (HIT). In all the disciplines studied (alpine skiing, cycling, cross-country skiing), interventions of highly concentrated blocks evoked more beneficial training responses than traditional mixed programs with the same quantity of highly intensive sessions [29–31, 34].

In addition to the studies listed in the table, the benefits of multi-targeted long-term BP programs were reported in publication by the Olympic canoe champion Klementiev [35] and the outstanding performances of the Belorussian canoe-kayak national team in the Athens Olympic Games [36]. The benefits of BP training program have been found in the preparation of highly qualified race walkers [37].

3.2.2 Outcomes of Studies Conducted in Team and Dual Sports

A number of studies aimed to evaluate BP training effects in soccer and tennis. Only elite and sub-elite athletes were examined in these works (Table 5).

Two studies evaluated the effect of using three block types for in-season preparation of elite Spanish soccer players [40, 41]. This implementation of the BP approach resulted in significantly enhanced game activity following the realization block mesocycle [40]; another study revealed a more favorable trend of soccer-specific fitness estimates when the training program was compiled using

Table 4 Effects of multi-targeted block periodization training in endurance sports

Study	Study design	Effects
Issurin et al. [27]	T program (1 season) vs. BP design using 3 block-types (2 seasons); 3 years, 23 EM kayakers	Significant superiority of BP program in power, propulsive efficiency and performance time in 1000-m kayak
Garcia-Pallares et al. [28]	T design vs. BP design using 3 block types; 2 years, 10 EM kayakers	Significant superiority of BP program in kayak peak performance and peak power; earned Olympic gold medal
Breil et al. [29]	BP program (HIT aerobic block) vs. T mixed program; 11 days, 21 EM junior alpine skiers	Superior effect of BP program on VO_{2max} and anaerobic threshold power
Rønnestad et al. [30]	BP program (1 week HIT +3 weeks LIT) vs. T mixed program; 4 weeks, 21 SEM cyclists	Superiority of BP group in VO_{2max} and power output at 2 mmol/L although volume/intensity was similar to T group
Storen et al. [31]	BP program (4 months with 2 blocks HIT 9 and 10 days) vs. mixed T program; 2 seasons; one EM cyclist, case study	Superior gains of VO_{2max} and time trial performance following BP program
Bakken [32]	BP program: 5 weeks with 2 weekly blocks of HIT vs. T program; 19 SEM skiers	Significant benefit of BP program in VO_{2max} and time to exhaustion
Alecu [33]	BP annual program (5 stages, 3 block types) vs. T program; EM kayakers, senior vs. junior national teams; one season	Superiority of BP plan in endurance trials, multi-peak performances and optimized training volumes
Rønnestad et al. [34]	BP program: (1 week HIT + 3 weeks LIT) × 3 times) vs. T mixed program; 12 weeks; 15 SEM cyclists	Superiority of BP group in VO_{2max}, power output at 2 mmol/L and power output during 40-min all-out trial

3 block types: accumulation, transmutation, and realization mesocycles

BP block periodized, *E* elite, *HIT* high-intensity training, *LIT* low-intensity training, *M* males, *SE* sub-elite, *T* traditional, VO_{2max} maximum oxygen uptake

Table 5 Effects of multi-targeted block periodized training in team and dual sports

Study	Study design	Effects
Stolen et al. [38]	Aerobic HIT block vs. continuous dribbling program; 10 days; 20 SEM soccer players	Superior gain of VO_{2max} in BP group (7.3 vs. 1.7 % in T group) and more favorable game activity
Porta and Sanz [39]	Annual plan based on 3 block types, single case study with E tennis player	Outstanding performances of Carlos Moya in 2002–2004
Mallo [40]	BP annual plan based on 3 block types; four seasons, 77 E soccer players	Significantly better performances following realization block-mesocycle
Mallo [41]	Annual plan divided into 5 stages with 3 block types; 22 E soccer players	Significant gains in jumping performance, sprint, and Yo-Yo recovery test
Wahl et al. [42]	Single block of aerobic HIT program; 2 weeks, 12 SE soccer players, one group	Significant gains in sprint abilities by 46 % and Yo-Yo endurance by 24 %

3 block types: accumulation, transmutation, and realization mesocycles

BP block periodized, *E* elite, *HIT* high-intensity training, *M* males, *SE* sub-elite, VO_{2max} maximum oxygen uptake

accumulation, transmutation, and realization mesocycles [41].

A similar BP approach was utilized in a single case study with a world-leading tennis player, Carlos Moya [39]. His modified BP program caused a remarkable increase in athletic preparedness and the attainment of higher world rankings in 2002–2004. Two other studies showed the increased effectiveness of including short-term blocks of an HIT aerobic program (10 and 14 days) in pre-season preparation of sub-elite footballers [38, 42]. In both cases, the authors reported substantial enhancement of specific fitness and game activity.

It is worth noting that the specificity of team sports prompted the creation of original modified BP training plans with shortened accumulation, transmutation, and realization phases [43]. The principal elements of the multi-targeted BP approach were successfully applied in the design and implementation of a soccer-specific fitness program [44].

3.2.3 Outcomes of Studies Conducted with Strength/Power Athletes

A number of studies have been conducted that apply BP principles in the preparation of strength-power athletes (Table 6).

The content of the sequenced blocks was appropriately adapted for strength training. The more generalized blocks were directed to muscular hypertrophy and lasted from 5 weeks [45, 48] to 10 weeks [46]. The subsequent blocks were directed to more specific neuromuscular adaptations that determine the manifestation of power and explosive strength abilities. Similar block sequencing was implemented in a study with well-trained track and field athletes, which developed, in sequence, general strength, endurance, and strength/power [47]. This BP version appeared to be more favorable than a mixed daily undulated program.

It is important to note that evidence from BP studies of strength/power athletes generally correspond to the planning framework of Poliquin [49], who proposed the creation of a basic platform (hypertrophy) followed by a speed/power block and then by a performance-specific program.

It is worth noting successful attempts to apply the multi-targeted BP approach in the long-term preparation of power lifters [50], body builders [51], and judo athletes [52]. In all these cases, properly structured strength workloads were allocated in the accumulation, transmutation, and realization block mesocycles.

3.2.4 Study Outcomes of Recreational BP Training

Although previous publications contended that the BP approach is best suited to high-performance sport [21, 26], some special cases of recreational training exist in which only block structuring can provide a proper solution to a health-related problem. Osteoporosis and the risks of bone fractures affect about 55 % of the population aged >50 years [53]. Thus, strengthening the bones is extremely important for many elderly individuals and especially for females. Administration of a traditionally designed 28-week resistance training program did not result in increased bone mineral density (BMD) in the lumbar spine and femoral neck, although muscle strength was enhanced [54]. The real solution of this problem was found in another study, in which a block-structured program led to a distinct improvement of bone status [55].

The 12-month study of 85 postmenopausal women, which compared traditional low-intensity/low-volume fitness training and the BP structured program, consisted of four metabolic and four 'bone' blocks [55]. The metabolic blocks were intended to increase cardiorespiratory fitness, and the 4- to 6-week 'bone' blocks included highly concentrated drills to stimulate bone density, such as jumps,

Table 6 Effects of multi-targeted BP training in strength/power athletes

Study	Study design	Effects
Herrik and Stone [45]	3 blocks program: hypertrophy, strength/power, peak performance vs. progressive resistance T design; 15 weeks, 20 RF athletes	Significant superiority of BP group in 1RM bench press and parallel squat
Hartmann et al. [46]	2 blocks design: hypertrophy (10 weeks) and strength/power (4 weeks) vs. DUP mixed program, 14 weeks, 40 RF athletes	Significant superiority of BP group in 1RM bench press, isometric force, and rate force development
Painter et al. [47]	BP design: 3 blocks: strength, endurance, and strength/power vs. DUP mixed; 10 weeks, 25 SE track and field athletes	Significant superiority of BP group in amount of improvement per estimated work volume
Bartolomei et al. [48]	BP design: 3 blocks: hypertrophy, strength and power vs. T design: progressive load increase; 15 weeks, 25 RF athletes	Superior gains of BP group in strength/power of upper body; no difference between groups in lower body muscles

BP block periodized, *DUP* daily undulated program, *RF* recreational fitness, *SE* sub-elite, *T* traditional, *1RM* one repetition maximum

high resistance efforts, barbells, and functional gymnastics. Ultimately, the BP program yielded significantly more favorable results than control group training impact on both bone status and wellness estimates.

It can be suggested that the outcomes of this study illustrate successful application of the BP approach to specialized training programs for recreational athletes.

4 Conclusion

It would be a regrettable mistake to think that the traditional theory of training should stay the same within the older paradigms despite the tremendous changes that have occurred in the world of sport and the dramatic progress of sport science. The shortcomings of traditional theory have been noted repeatedly in previous publications [56–59], and, in comparison, the newer innovative training concepts look reasonable and desirable. The aim of increasing training stimulation within the framework of traditional theory led to a dramatic elevation in workload magnitude and the dissemination of harmful pharmacological technologies [60]. Implementation of highly concentrated workloads instead of further increasing training magnitude appears to be a practical, scientifically based way to improve the preparation of high-performance athletes. Therefore, such coaching concepts as 'block', 'block structure', and 'block periodization' have become a reality in contemporary sport and an indispensable part of theory of training.

The present review characterizes and differentiates between two innovative versions of BP training approaches. It was noted and should be emphasized that the CU training model has been proven effective mostly in the jumping disciplines, which require a relatively narrow range of targeted abilities [4, 5]. It can be accepted that this BP training version has the potential to improve one main fitness component, but has serious restrictions when applied to sports and disciplines where peak performance demands many targeted abilities. The multi-targeted BP training model was created and implemented based on the experiences of high-performance athletes in canoe–kayak paddling [3, 27], track and field [6], and swimming [7, 8]. In all these cases, sport-specific preparedness and peak performance are firmly based on a number of targeted abilities. The sequencing of block mesocycles focusing on the appropriate combination of compatible training modalities prompts correct interaction and the superposition of training effects producing by the entire preparation program.

The outcomes of numerous studies conducted during recent decades give relevant information concerning the benefits and limitations of both BP training models. The studies evaluating the effects of CU training programs during athlete preparation in multi-targeted sports did not indicate any remarkable positive impact on event-specific performances [13–17]. In contrast, the benefits of multi-targeted BP training programs were supported by the findings of 28 studies conducted in different sports. For instance, the superiority of the multi-targeted BP training system was confirmed by the outcomes of long-term studies with the national canoe–kayak teams of four countries: USSR [27], Spain [28], Romania [33], and Belorussia [36].

Apparently, both BP training versions were proposed for the preparation of high-performance athletes. Indeed, almost all of the studies mentioned in this paper were conducted with elite, sub-elite, and well-trained athletes. It was claimed that low- and medium-level athletes are sufficiently sensitive to any kind of training stimuli and thus can benefit sufficiently from traditionally designed programs [60]. In fact, proper analysis gives no evidence that amateur athletes have any serious restrictions when implementing highly concentrated workloads structured in blocks of optimal duration. Moreover, the findings of the study with aged recreational female trainees showed the block-structured program to be considerably superior to the traditional version [55]. These recent data make it possible to suppose that BP training can also reasonably be extended to other age and ability groups.

To conclude this review, the following recommendations can be proposed for practice:

1. The CU training strategy is suited to athletic disciplines requiring one fitness component (e.g., jumping performance etc.).
2. The multi-targeted BP system is suited to sports and disciplines, such as endurance, team, combat, and aesthetic sports, that require the application of many athletic abilities.
3. The BP training models can reasonably be used in the preparation of recreational athletes.

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