PERIODIZATION TRAINING FROM ANCIENT PRECURSORS TO STRUCTURED BLOCK MODELS

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Review

Abstract:

Periodization training is correctly considered to be one of the principal issues underlying the theory of athlete preparation. Its historical roots are associated with celebrated treatises by ancient philosophers, while its later conceptualization is closely connected with the formation of the underpinnings of contemporary coaching sciences. The present-day classic version of periodization training was initiated with publications in the early 20th century and reached its culmination with the appearance of Matveyev's distinguished book, which is considered a landmark in training fundamentals. Further development of high-performance sport and the revelation of new facts, knowledge and technologies have affected later alternative versions of periodized training, some of which have been used by elite athletes in different sports with remarkable success. On the other hand, the appearance of alternative concepts, such as block periodization (BP), has aroused the interest of several researchers who have engaged in further studies. Since then a number of research projects have been conducted in various sports and their outcomes have demonstrated the benefits of BP models in enhancing metabolic, neuromuscular and sport-specific variables of athletic preparedness. The present review summarizes these elements, highlighting the contribution of the latest studies to the methodology of high-performance training.

Key words: *training periodization, ancient roots, alternative planning concepts*

The aim of the present review paper is to reconstruct salient landmarks in the establishment of contemporary training periodization. As part of this general aim the following items are considered: an historical overview from ancient precursors of the classic version, the appearance of alternative periodization concepts, and the latest outcomes of block structured models.

Historical overview

"How should efficient training be designed for athletes?" is a question that has long engaged prominent thinkers, analysts and practitioners. Indeed, the history of the development and implementation of periodized training dates back more than two thousand years, to famous ancient philosophers and physicians. Galen (*Claudius Aelius Galenus)* introduced the first description of strength training periodization, and Lucius Flavius Philostratus presented the first structured model of pre-Olympic preparation (Gardiner, 1930; Drees, 1968).

The modern Olympic era has spurred activity related to athletic training. Perhaps one of the first monographs devoted to high-performance sport training was published by Boris Kotov. His book, "Olympic sport" (1916), introduced the original concept of periodized training that proposed three stages of purposeful athletic preparation: general fitness preparation, more specialized training, and specific preparation for forthcoming competition.

The theoretical background of periodized athletic training was further developed in a valuable publication by Lauri Pihkala (1930), who postulated a number of principles such as dividing the annual cycle into preparatory, spring and summer phases and active rest ending the season. He also introduced the principles of sequencing extensive and intensive workloads, focusing on the proper "work : rest" ratio in training design and the basics of long-term athletic preparation. The know-how of the 1930s was adapted and used in several textbooks published in the USSR for skiing (Bergman, 1938), swimming (Shuvalov, 1940), track-and-field (Vasiljev & Ozolin, 1952).

The outstanding landmark in training theory was the monograph published by Lev P. Matveyev (1964), which summarized the available information on training periodization and proposed a general approach to planning, which eventually became known as the "classic" approach. At that time, when training theory suffered from too little objective knowledge and insufficient scientifi-

cally based training guidelines, Matveyev's book was a veritable breakthrough in coaching science. Therefore, the periodization model with its logical structuring of athlete preparation and its clear hierarchy of training cycles and units became a universal tool for planning and training analysis in all sports for athletes of varying levels of performance. At the same time, this dominant training concept spread and appeared elsewhere around the world in the works of other authors, such as Harre (1973), Martin (1980), Bompa (1984), etc.

Alternative periodization concepts

One of the first attempts to revise traditional periodization was made by Yuri V. Verhoshansky (1985, 1988), who proposed and elucidated the original model of concentrated unidirectional block periodized training. The principal premise of this training concept was to give priority to highly concentrated training workloads intended to develop a selected targeted ability through strong training stimulation. Based on the Verhoshansky's own studies and observations, mostly in the jumping disciplines, he proposed a model in which the administration of three specialized training blocks, intended to produce the desired training response, resulted in substantial enhancement of sport-specific motor output. Later studies conducted in team sports and swimming showed remarkable increases of fitness abilities but not in the event-specific variables (Moreira, et al., 2004: De Souza, et al., 2006; Campeiz & de Oliviera, 2007; Marinho, 2008). It can be suggested that the concept of concentrated unidirectional training offers a reasonable approach for preparing athletes in disciplines requiring a relatively small number of targeted abilities such as jumping. In preparing athletes who need to develop and excel in a larger number of sport-specific abilities, such as in team, combat and endurance sports, the unidirectional approach does not provide the balanced multilateral training that enables athletes to attain optimal athletic preparedness and peak performance.

Another alternative version, which can be termed the multi-targeted block structure model, presupposes the sequencing of specialized blocks-mesocycles intended to develop minimally compatible targeted abilities within each block. The earliest studies in which this block periodization (BP) model was used were in canoe-kayak paddling (Issurin & Kaverin, 1985), track-and-field (Bondarchuk, 1986), and swimming (Pyne & Touretski, 1989; Touretski, 1993). In all these cases the researchers compiled three specialized blocks where workloads were focused on the sequenced development of basic athletic abilities; specific athletic abilities; pre-competition tapering, restoration and peak-performance. The total duration of all the blocks-mesocycles (usually three) varied from 6 to10 weeks and formed a single training stage. Thus the annual plan was compiled as a sequence of several training stages (for a detailed description see Issurin, 2008, 2010). Despite the very different training conditions and competition demands of the three sports mentioned, the training approaches utilized by the researchers were very similar. In all these cases the use of BP programs led to outstanding results: the USSR canoe-kayak team earned three gold, three silver and two bronze medals at the Seoul Olympic Games; the athletes coached by Dr. Bondarchuk all earned Olympic medals in hammer throwing at the Seoul and Barcelona Olympic Games; and Alexander Popov and Michael Klim, coached by Touretski, earned five and two Olympic gold medals, respectively, at the Barcelona and Atlanta Olympic Games.

In light of the multi-targeted BP model described above, the following details should be kept in mind:

1) In sequenced specialized mesocycle-blocks, highly concentrated training workloads are focused on a minimal number of motor and technical abilities. Unlike traditional training periodization, which concentrates on the simultaneous development of many abilities, the alternative BP concept advocates for the consecutive development of the targeted abilities in successive mesocycle-blocks.
2) Unlike the concentrated unidirectional BP model, this version presupposes the simultaneous development of several compatible abilities/targets using logical block sequencing. This training structure is based on *residual training effects*, i.e., the retention of changes brought about by the training that remains after the actual training has already ceased. These training residuals are especially important when athletes improve their abilities consecutively, not concurrently, as in the traditional model.
3) The multi-targeted BP model utilizes an original taxonomy of mesocycles that consists of three types of specialized blocks: *accumulation,* for developing basic motor and technical abilities (mostly aerobic and muscle strength abilities as well as basic technical skills); *transmutation,* for developing event-specific abilities (mostly anaerobic and/or aerobic-anaerobic abilities and more specialized technical skills), and *realization*, for maximal speed, event-specific tactics and full restoration prior to the forthcoming trial or competition (this block is very similar to the widely-known pre-event tapering).

Outcomes of the most recent studies examining the block structure model

BP training models have been implemented and applied for more than three decades. Nevertheless, only now, following several publications and exten-

sive debates in various coaching forums and electronic databases, BP as a coaching concept and research approach, has become rather popular among training analysts and practitioners. As a result, a number of research projects evaluating BP training models have been completed. Table 1 summarizes the outcomes of several studies that examined the effectiveness of multi-targeted BP training. In all cases training effects were evaluated using reliable objective methods, matched control groups or training stages, where training outcomes were compared after the traditional and BP programs were implemented. The papers published in peer-refereed journals, scientific PhD and MSc theses are referenced.

The first publication introducing the outcomes of long-term studies was presented as a scientific report summarizing findings from monitoring the preparation of the USSR elite canoe/kayak paddling team for the Seoul Olympic Games (Issurin, et al., 1988). The study compared seasonal training effects using the traditional and BP programs. Training outcomes were evaluated using multichannel telemetry during all-out 1000 m performance and power determination on a stroke simulated mechanical ergometer. The superiority of the BP model was confirmed with objective event-specific indicators and outstanding results in the targeted competition.

The study of top-level kayakers was conducted in the framework of pre-Olympic preparations of the Spanish national team during two successive annual seasons, where the first season was planned according to the traditional model and the second one followed BP guidelines (Garcia-Pallares, Garcia-Fernandez, Sanchez-Medina, & Izquierdo, 2010). Training in the BP stage was characterized by a substantially lower training volume but a higher contribution of workloads, which reached 50-60% of the total volume directed at the selected targets. The duration of the accumulation and transmutation mesocycles was five weeks, while the taper (realization) mesocycle lasted three weeks. Implementation of the BP program led to a significant increase

Table 1. Summary of studies evaluating BP programs in various sports

Sample	Training description	Study outcomes	Source
23 male elite canoe/ kayak paddlers aged 24.8±3.2 yrs, training experience 9-17 yrs	Three annual seasons: one season with traditional design vs. two seasons with the BP structured program.	Superiority of BP program in on-water power output, propulsive efficiency and power on stroke simulated ergometer (P<.05). Superior performances in world athletic events.	Issurin, et al., 1988
10 male elite kayakers aged 25.6±2.5 yrs, training experience 11.2±2.7 yrs	Two consecutive annual seasons: traditional design vs. BP structured program.	Significant superiority of BP program in kayak peak performance (gain of 6.2 vs. 3.4%) and in kayak peak power (gain 14.2 vs. 6.0%). Earned gold medal in the Beijing Olympic Games.	Garcia-Pallares, et al., 2010
21 elite junior alpine skiers; two groups: BP and traditional (T) design	BP group: 11 days high intensity aerobic program, i.e., 4 x 4 min at 90-95% of HRmax. T group: conventional endurance/ strength program	Significant increase of VO_{2max} by 6%, peak power output by 5.5% and power output at ventilatory threshold by 9.6%. No changes occurred in T group.	Breil, et al., 2010
77 professional soccer players aged 24.8±3.5 yrs. from 3 teams of the same Spanish division	Each season was subdivided into stages and blocks according to Issurin (2008) with appropriate program of preparation.	Significantly higher results were obtained following realization block, lower results were after accumulation and ending transmutation block.	Mallo, 2011
25 trained track-and-field athletes aged 18-22 yrs: fitness training – BP and DUP groups	10 wks, 3 session/wk. BP group: separate blocks for strength, endurance, strength/ power; DUP group: weekly sessions for strength endurance, strength and power	BP program caused a favorable performance trend and significant superiority in amount of improvement per estimated volume of work and calculated training efficiency scores.	Painter, et al., 2012
15 trained male cyclists aged 33±6.5 yrs; two groups: BP vs. traditional (T) design	12 wks training: BP –combination of one week of high intensity and three weeks of low intensity training was repeated 4 times; T program – 12 weeks mixed program	Superiority of BP program: larger gain of VO_{2max}, peak aerobic power, power output at 2 mmol/L; moderate BP effect on mean power output during 40 min all-out trial	Rønnestad, et al., 2014
19 sub-elite cross-country and biathlon skiers aged 22.5±7 yrs; BP and T groups	BP – high intensity training (HIT) in the 1st and 3rd wk (5 and 3 sessions, respectively) and 1 HIT session in other weeks vs. T design – 2 HIT each week. Total: 5 weeks	BP group increased VO_{2max} by 2.6% (P<.05) and work time to exhaustion by 6.1% (P<.01) as compared to control group that did not show any significant changes	Bakken, 2013

Abbreviations: BP – block periodization; HR – heart rate, DUP – daily undulated program, VO_{2max} – maximum oxygen uptake.

in velocity, power and stroke efficiency in terms of maximum oxygen uptake. Following the annual season based on the traditional design, none of the athletes qualified for the Beijing Olympic Games, whereas the preparation conducted according to the BP program helped the team to earn four quota places and one crew (Saul Graviotto and Carlos Peres) earned an Olympic gold medal.

The next study, with junior elite alpine skiers, was devoted to the examination of high intensity blocks of aerobic training (Breil, et al., 2010). Two groups of skiers performed parallel programs for 11 days. The athletes in the BP group performed intermittent sets 4 x 4 min at 90-95% of maximal heart rate with 3-minute recovery intervals. During this study the athletes performed 12 aerobic sessions on a cycle ergometer and three similar sessions on a ski specific running course. This concentrated aerobic program was combined with usual core and upper-body strength exercises. The skiers in the control group performed traditional endurance and strength training equal to the BP group in the number of sessions and time expenditure. Post-intervention testing was administered seven days after the completion of the training programs. The outcomes of the study revealed significant and impressive enhancement of maximal aerobic consumption, peak power output and power output at the second ventilatory threshold. The athletes in the control group showed no change in their fitness variables. Although metabolic aspects are not dominant in alpine skiing, the study results look promising for high-performance skiers giving them the possibility of rapidly enhance their aerobic potential.

A long-term study involving 77 elite soccer players was conducted over a period of four seasons. Each season was subdivided into three stages consisting of accumulation (A), transmutation (T) and realization (R) mesocycles-blocks (Mallo, 2011). These blocks were composed of the following exercises and training forms: high-intensity aerobic workloads and gym-based strength (A); sprint abilities and speed endurance exercises carried out at near-maximum intensity (T); and a soccer-specific tapering program (R). Ultimately, the physical conditioning training represented 31-34% of the total training time, while the remaining time was allocated to multiple technical and tactical drills. The results in competitions were categorized depending on the rank of the opposing team and the success level, i.e., win, draw or defeat. The most successful performances were observed following the realization mesocycles; the accumulation program resulted in lower effectiveness, and the less successful performances were executed after the transmutation mesocycles. It was concluded that in this approach to planning, the most important matches should be played after the realization mesocycles, whereas the other blocks can be structured around the priorities of other matches.

A BP strength training program was evaluated in a study conducted with track-and-field athletes experienced in strength/power activities (Painter, et al., 2012). The BP group program was divided into three mesocycles: strength endurance (3 wks), strength (3 wks), and power (4 wks). Appropriate intensity levels, numbers of sets and repetitions were specified for each mesocycle and each week. The second group practiced a daily undulated program (DUP), which was based on a weekly plan consisting of one session for strength endurance, one for strength and one for power. Statistical analysis revealed significant gains in strength/power variables in both groups with the BP program subjects showing moderate superiority. However, the analysis revealed a significantly higher load volume in the DUP group as estimated by the total number of repetitions (+52%) and total estimated mechanical work (+35%). Correspondingly, the improvement per estimated load volume was markedly higher in the BP group as compared to the DUP group.

A similar study was conducted with two groups of trained Norwegian cyclists (Rønnestad, Hansen, & Ellefsen, 2014). In this 15-week study, the BP group (n=8) executed a one week high-intensity aerobic block with five intensive sessions followed by a three-week low-intensity routine including one high-intensity aerobic session per week; this four week cycle was repeated three times. The control group (n=7) performed two high-intensity aerobic sessions per week and three sessions of low-intensity training. Ultimately, the total volume of high- and low-intensity workloads in both groups was identical. It was found that the BP program participants manifested significant superiority over the control group in maximum oxygen uptake gain, hemoglobin mass, power output at a lactate level of 2 mM/l, and during a 40-min all-out time trial. Apparently, the BP design was more efficient in terms of both the metabolic and sport-specific variables.

An original study of a BP program was carried out by Bakken (2013) with highly qualified Norwegian cross-country and biathlon skiers. The author, a world famous elite cross-country skier, proposed a 5-week mesocycle with two microcycles of highly concentrated intensive aerobic workloads, whose outcomes were compared with a traditionally designed mesocycle. The study was conducted during an early competitive period, and the total mileage of high and low intensive exercises in both programs was identical. The final evaluation of maximal oxygen uptake and work time to exhaustion revealed the BP program to be significantly superior.

Summarizing this section it is worth noting that no study has been found (including publications not referenced in this review) in which the traditional model yielded results superior to the BP program.

Conclusions

Periodization training, as a methodological concept, practical approach and professional consideration, is raising ever increasing interest and drawing attention from researchers, training analysts and practitioners. Its history has ancient roots and embraces memorable treatises by prominent scientists of the past and the present. This classic background as well as alternative versions has expanded the areas of discussion, elucidation and practical application of this methodology. It is to be hoped that further progress in the sport sciences will lead to new in-depth studies, clarification of present periodization models and the appearance of new versions, which may broaden the horizons of our knowledge.

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PERIODIZACIJSKI TRENING OD DREVNIH PRETHODNIKA DO STRUKTURIRANIH BLOKOVSKIH MODELA

Periodizirani trening se s pravom smatra jednim od osnovnih koncepata koji su u pozadini teorije sportske pripreme sportaša. Njegovi povijesni korijeni su povezani sa slavnim tezama koje su postavljali drevni filozofi, dok je kasnija konceptualizacija usko povezana s formiranjem suvremene sportske znanosti (teorija treninga). Današnja klasična verzija periodizacijskog treninga pojavila se u publikacijama tijekom ranog 20. stoljeća te je dosegnula svoju kulminaciju pojavom istaknute Matvejevljeve knjige koja se smatra kamenom temeljcem teorije treninga. Daljnji razvoj vrhunskog sporta i otkrivanje novih činjenica, znanja i tehnologija utjecali su na kasnije izmijenjene verzije periodiziranog treninga koje su u svojoj sportskoj pripremi rabili vrhunski sportaši iz različitih sportova, a rezultirale su značajnim uspjesima. S druge strane, alternativni koncepti, kao što su blokovska periodizacija (BP), pobudili su interes nekoliko istraživača koji su se uključili u daljnja istraživanja. Od tada je provedeno nekoliko istraživačkih projekata u različitim sportovima i njihovi rezultati su pokazali sve prednosti BP modela u poboljšanju metaboličkih, živčano-mišićnih i specifičnih sportskih varijabli sportske pripremljenosti sportaša. Ovaj pregledni rad sažima navedene elemente, naglašavajući doprinos najnovijih istraživanja metodologiji treninga u vrhunskom sportu.

Ključne riječi: *periodizacija treninga, drevni korijeni, alternativni koncepti planiranja*