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ORIGINAL RESEARCH

MODALITIES OF TRAINING PARAMETER ALTERNATION IN NOWADAYS STRENGTH TRAINING PRACTICE

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Abstract

Large number of variables could be alternated during the process of planning and programming in sports training. Superior training results in majority of sports are achieved by optimally manipulating training parameters in appropriate sequences and combinations. Additionally, in some sports they might be the result of appropriate periodization pattern. Today's tendency in strength training practice is training movements instead of training muscles. Exercise classification according to the dominant movement types, allows creating new modalities in training alternation. Additional variations in volume, intensity, rest brakes, repetition velocity and inter-repetition rest can be the important part of functional strength training program. Alternation and combination of different training parameters makes appropriate training stimulus for strength increase in the most of nowadays sports. Optimal alternation of basic training parameters should be the first part in the process of planning and programming. As a result, majority of athletes might not need advanced periodization patterns for optimal improvement in muscle strength and power.

Key words: strength training, training parameters, exercise classification, variation.

Introduction

Principles of strength training (ST) organization across the large cycles are relatively strict and well known. Macro-cycles of concentrated or distributed load as well as block periodization principles are well explained in many research papers and textbooks (Issurin, 2008; Issurin 2009; Siff, 2000; Zatsiorsky & Kraemer 2006). In micro- and meso-cyclic periodization, there are much more training variables and modalities that could be manipulated. However, studies about the exact effects of operating those variables in training process are still insufficient.

Despite large number of scientific papers that examine the problem of periodization, the science supporting the application of periodization is inadequate in scope (Cissik et al., 2008). Therefore, periodization theory is based largely on empirical evidence (Plisk & Stone, 2003), practical experience of elite coaches (Baker, 2007) and additionally, most of the information from the literature is conjectural and not supported by research (Cissik et al., 2008).

Numerous studies about periodization involving experimental periods no longer than 2–3 months, using subjects with no, or limited training experience (Baker, 2007; Cissik et al., 2008). Multiple-mesocycles or integrated studies (e.g., combined strength/power and speed/endurance training) on advanced athletes are not published yet (Plisk & Stone, 2003).

Deep analyze of periodization in large cycles (monocyclic, two-cyclic and three-cyclic variant) requires the information's about training modalities used in every smaller cycle. However, present scientific papers that explain the periodization of ST throughout large cycles, does not present the training variables in smaller cycles.

Present studies and created theoretical models are insufficiently explained for practical application in training process. However, the available scientific evidence (Stone et al., 1999a, Stone et al., 1999b) supports

that as first periodization seems to be a superior approach to strength/power training even over the short term, especially in previously trained subjects and as second, optimal results are achieved by optimally manipulating training parameters in appropriate sequences and combinations (Plisk & Stone, 2003). Based on the training objectives, there is large number of variables that could be manipulated in ST. Therefore, the purpose of this article is to analyze modalities of alternation in different training parameters in nowadays ST practice.

Phases, goals and loads in strength training

Making a ST program require being familiar with the fundamentals of ST. Although principles of periodization are still not standardized, the most commonly mentioned principles of ST are progressive overload, specificity and variation (Kraemer & Ratamess, 2004).

ST usually consists the following phases: anatomic adaptation, muscle hypertrophy, maximal strength and conversion of maximal strength to sport specific speed strength, explosive strength or strength endurance (Bompa & Carrera, 2005; Bompa & Haff, 2009; Bompa et al., 2003). Depending on the specific program design, ST can improve muscle strength, power, or local muscular endurance (Deschenes & Kraemer, 2002), motor performance and muscle hypertrophy (Fleck, 1999). Every phase has specific purpose and therefore, ST objectives must be incorporated into those phases. If analyzed through percentage of one repetition maximum (1RM), ST might develop strength endurance (15-20RM), muscle hypertrophy (6-12RM), maximal strength (1-5RM) and power or speed-strength (30-70% of 1RM with dynamic effort). Additionally, there are hybrids or mixed training zones with influence on both strength endurance and muscle hypertrophy (12-15RM), maximal strength and muscle hypertrophy (4-6RM), etc.

Variability of training parameters

Construction of optimal ST program is very complex. Basic criterions that must be analyzed are training objectives, phase of ST and type of strength primary important for particular sport. Although for creating ST program, coaches mostly use manipulation with two main training variables - training volume and intensity (Bompa & Carrera, 2005), there are other numerous training variables that could be manipulated.

During realization of strength program, it is possible to change the training influence by varying: type of exercise, intensity, number of repetitions, number of sets, type of muscle actions, the speed of perfoming the exercise, order of exercises, rest periods between sets, training frequency, and number of training session per day or per week (Baker, 2007; Kraemer & Ratamess, 2004; Fleck, 1999).

Additionally, very important factors for variation in training stimuli are order of strength workouts in micro-cycle and structure of micro-cycle when workouts with different training influence are employed.

Training effects are influenced by summated load from different training modalities during training week. For example, if we implement ST twice per week with full rest between workouts we will most probably produce the improvement in strength.

On the other side, if we incorporate additional speed endurance training between strength workouts, second strength training will be realized under the fatigue of endurance workout and effects will be different. As a result, we can also vary the ST stimulus throughout altering the order of workouts with different training stimulus.

Table 1. Classification of basic training parameters used for alternation of the training stimulus.

	Training parameters					
No.	Training goal	Exercise type	Movement type	Type of muscle action	Speed of contraction	Type of rest
1.	Maximal strength	Total body	Flexion	Isometric (ISO)	Fast ECC-CO	Complete
2.	Hypertrophy	Lower body	Extension	Concentric (CO)	Slow ECC-CO	Incomplete
3.	Strength endurance	Upper body	Rotation	Eccentric (ECC)	Moderate ECC-CO	Inter-repetition
4.	Speed strength	Core	Abduction	ECC - CO	Fast ECC-Slow CO	/
5.	Explosive strength	Hybrid	Adduction	ECC - ISO - CO	Slow ECC-Fast CO	/
6.	/	/	Hybrid	/	/	/

Beside basic parameters of intensity, volume and movement type, training variation can be accomplished by changing different parameters presented in table 1. If we take hypertrophy of lower body as an example for ST goal, we can select extension exercises with slow eccentric and slow concentric actions, with incomplete rest between sets.

Opposite to this, we can program the same training with only slow eccentric actions and complete rest. Additionally, the same goal can be accomplished with eccentric - isometric - concentric actions, inter-repetition rest and moderate speed. If we incorporate total body and core exercises in the same workout, training influence on hypertrophy can be additionally changed. All of the presented modalities can alter the training influence, accomplish training goals and provide appropriate training variability.

Basic principles of exercise order must be considered throughout constructing the appropriate ST programs. According to Zatsiorsky & Kraemer (2006), highly neural demanding, multi-joint or total body exercises such as power clean, snatch, clean pull, etc., should be performed first on the workout. Therefore, whether the workout is performed during on- or off-season, those principles must be respected.

The principle of training movements (Zatsiorsky & Kraemer, 2006) and so called `functional strength training` (Boyle, 2003) substituted the old bodybuilding concept of isolated muscle training (Bompa et al., 2003; Stoppani, 2006) where the exercise classification is made according to dominantly used muscles. Although this might be accepted in sports like bodybuilding, for all other sports where functional muscle strength is essential, exercises should be classified according to movement categories (Boyle, 2003; Kenn, 2003).

Table 2 presents classification of fundamental exercises with 'barbell' and 'dumbbells' according to movement categories.

Table 2. Classification of basic strength & power exercises according to movement categories.

Exercise type	Movement category	Bilateral	Unilateral
Total body	Hybrid	Snatch, clean, jerk, hang pull	Dumbbell snatch, dumbbell clean
Lower body	Knee dominant	Back squat, front squat	Single leg squat
	Hip dominant	Deal lift, Romanian dead-lift, good morning	Step-up, lunge, split squat
Upper body	Vertical push / Vertical pull	Standing press / Pull-ups, chin-ups, upright-row	Dumbbell press / One arm pull
	Horizontal push	Bench press, incline press, push-ups	Dumbbell press, dumbbell incline press
	Horizontal pull	Lying row, reverse row, pull-over	Dumbbell row, one-arm rotational row
Core	Abdominal dominant		
	Trunk dominant		
	Rotational		

Therefore, training different movements and improving strength in those movements allows strength coach many different modalities in varying exercises and intensities.

While during competitive period, training frequency of two times per week is often recommended (Wathen & Baechle, 2000), the majority of ST programs during preparation period is based on three workouts per week (Kutzer, 1995; Marshall, 2005). Old traditional concept of split training routines (Bompa et al., 2003; Stoppani, 2006) is altered with training of the movements. Although the application of split training is still applicable and noticed in some studies (Prestes et al., 2009; Kerksics, et al., 2009), the majority of present studies use training according to movement categories with one exercise per category (Buford et al., 2007; Murray & Brown, 2006; Waller et al., 2007). Table 3 presents the example of three days per week training, with daily exercise variation according to movement categories.

Table 3. Example of training according to movement categories with one exercise per category.

Exercise No.	Movement category	Workout #1	Workout #2	Workout #3
1.	Total body	Hang snatch	Power clean	Hang pull (snatch grip)
2.	Lower body	Back Squat	Front squat	Back squat

3.	- knee dominant Lower body - hip dominant	Lunge	Step ups	Romanian dead lift
4.	Upper body - horizontal press	Bench press	Incline bench press	Bench press
5.	Lower body - assistant	Leg extension	Leg curl	Heel raise
6.	Upper body - horizontal/vertical pull	Lying barbell row	Pull-ups	Reverse row
7.	Upper body - vertical press/pull	Standing press	Upright row	Shoulder combo

In the sport practice some authors dominantly use changes in exercises and types of training on daily or weekly basis (Gamble, 2006; Jakovljević et al., 2009; Kenn, 2003), while other use the same exercises throughout entire meso-cycle but vary the loads using various periodization patterns (Grover, 2002; Kraemer & Fleck, 2007; Marshall, 2005) or integrate maximal velocity exercises (Murray & Brown, 2006). Movement category variations characterize only one of the possible modalities in training variation and therefore, strength and conditioning coach can direct the adaptation process toward specific goals by additionally varying loads (methods) within macro-, meso- and micro-cycles (Plisk & Stone, 2003).

Variability in speed of the performed exercises

Novel practices in the training program variation are manipulations in the exercise speed (Murray & Brown, 2006) and inter-repetition rest during the working set (Haff et al., 2008). Traditional realization of set require from an athlete to perform each repetition of the set in continuous way until the planed number of repetitions is completed without a rest between repetitions (Haff et al., 2003; Fleck & Kraemer, 1997).

Recently, novel method for training variation during the set was called 'rest-pause' or 'cluster set' (Haff et al., 2003; Haff et al., 2008; Fleck & Kraemer, 1997). Cluster set vary the training influence throughout implementing inter-repetition brakes 10-30 seconds long. This type of rest during the set may result in enhancement of movement velocity, barbell displacement, power generating capacity and more high quality work (Haff et al. 2008). Contrary, Murray and Brown (2006) use traditional continuous set, but vary the training influence through implementing exercises with maximal velocity. This type of training stimulus develops one's ability to reach a given velocity of movement more quickly, and thus improve acceleration and produce more muscular power close to competitive speeds (Murray & Brown, 2006). Both modalities are applicable in sport practice, although their effects are still under researches.

Variability in the exercise combinations

Three basic approaches used for power development are traditional weight training (80-90% 1RM), dynamic weight training (30-50% 1RM as fast as possible) and plyometric exercises represent (Docherty et al., 2004). In addition, complex or contrast training (Baker & Newton 2005) involves execution of a ST exercise with heavy load (1-5RM), followed by execution of a biomechanical similar plyometric exercise (Young et al., 1998). Table 5 presents example of complex exercise pairs.

Table 4. Basic exercise pairs used in Complex training.

Pair No.	Strength exercise	Plyometric exercise
1.	Snatch	Depth jump
2.	Squat	Jump squat
3.	Split squat	Split squat jump
4.	Lunge	Jump from lunge
5.	Bench press	Sitting Medicine ball chest throw

This type of training through stimulating neuromuscular system is effective for acute increase in lower body explosive force production and power of the lower and upper body (Baker & Newton 2005; Young et al., 1998). Although some authors suggest that lack of scientific evidence about long-term effects of this method still exists (Docherty et al., 2004), this type training variation seems to be very popular in coaching practice (Baker & Newton 2005; Grover, 2002; Marshall, 2005).

Variability of basic periodization patterns

Beside exercise selection and basic load components, probably the most essential part of nowadays ST is selection of the most appropriate periodization pattern. Periodization represents the systematic process of altering one or more program variable(s) over time to allow the training stimulus to remain challenging and effective (Kraemer et al. 2009). Additionally periodization is defined as a phase method of manipulating training

variables and is characterized by planned distribution or variation in training methods on a cyclic or periodic basis (Plisk & Stone, 2003) aimed at bringing or keeping an athlete at peak sports performance (Baker, 2007).

The effectiveness of the ST periodization largely depends on the used periodization patterns, the amount of variation in each pattern, the length of the study and the experience of the athlete (Baker, 2007; Wilks, 1995).

Baker (2007) systematized a number of periodization patterns for practical application. He recommended that instead using generalized term periodized ST, coaches and researchers should rather specify which pattern of ST periodization they use in practice. According to Baker (2007), there are five different patterns of intensification: subtle linear, block or step, undulating, wave-like and accumulation-intensification. Although the lack of scientific data and valid comparative studies essentially exists, it has been suggested that undulating, nonlinear approach might be the most appropriate in planning the season for team sports (Fleck & Kraemer, 1997; Wathen & Baechle, 2000). Which periodization modality is the most appropriate will be the question for further researches.

Challenges for practice

In contrast to the most of other variables, modalities and patterns that are not examined well enough, one of the rarely and relatively well-known facts in ST practice is the most appropriate value of training intensity. Average intensity for increasing and maintaining muscle strength seems to be the most effective at ≥ 80% (Hoffman & Kang, 2003) or 85% 1RM or ~6RM load (Peterson et al., 2004). Contrary, conclusions and optimal recommendations about other training variables are still far from reality.

Apart from recreationally trained subjects and novel athletes, information's about ideal volumes and intensities for speed, agility or weight training for top-level athletes are very limited (Cissik, Hedrick & Barnes, 2008). There are also insufficient information's about combining these workouts into different training cycles. All of the above mentioned are the practical problems, which should be solved in the future researches.

Conclusion

If there are so many options for training alternation using only training parameters, do we really need periodization patters? Presented variants for training alternation are most likely appropriate for the most of athletes. Disregarding typical strength and power sports like weight and power lifting, training variability that consists of alternation in training exercises, and basic changes in training volume and intensity, will be sufficient stimuli for preparation of the majority of athletes. The real importance of strength training periodization and exact effects of different periodization patterns should be examined in the future comparative researches. In view of presented modalities for training variation, it is possible to conclude that proper alternating of fundamental training parameters should be the first part of planning and programming in strength training.

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