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Effect of 16 Weeks of Periodized Resistance Training on Strength Gains of Powerlifting Athletes

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ABSTRACT

João GA, Evangelista AL, Gomes JH, Charro MA, Bocalini D, Cardozo D, Simão R, Figueira Júnior A, Silva DCS. Effect of 16 Weeks of Periodized Resistance Training on Strength Gains of Powerlifting Athletes. **JEPonline** 2014;17(3):102-109. The purpose of this study was to determine the effect of 16 wks of periodized resistance training on strength gains of 9 elite powerlifting athletes (men, 34.5 ± 5.0 yrs, 175.2 ± 7.8 cm, 94 4 ± 16.7 kg). The levels of strength ratings were determined by the 1RM test and divided into 5 stages (AS): AS1 - initial assessment, before the start of periodized training; AS2 - end of 1st 4-wk mesocycle and beginning of 2nd mesocycle; AS3 - end of 2nd 4-wk mesocycle and beginning of 3rd mesocycle; AS4 - end of 3rd mesocycle and beginning of 4th mesocycle; AS5 - end of 4th 4-wk mesocycle. Squat, bench press, and deadlift exercises were used to measure muscle strength. There was a significant increase in strength in all exercises and each assessment compared to the pre-training values ($P \leq 0.05$). After 16 wks of training, there was a 30Δ% increase in bench press, 33Δ% for squat, and 76.9Δ% for deadlift exercise compared to pre-training values. Thus, the results of this study indicate that linear periodization training applied in powerlifting athletes is an efficient method to increase muscular strength.

Key Words: Muscle Strength, Resistance Training, Powerlifting

INTRODUCTION

Resistance training (RT) has been used for diverse purposes such as aesthetic, rehabilitation, and health (11). It is one of the most effective methods to increase strength, power, and muscle mass (2). Also, it is known that the development of these attributes can enhance athletic and physical performance (10,12).

Powerlifting is a sport that requires the coordinated development of maximal muscle strength in three exercises: squat, bench press, and deadlift (12). Powerlifting athletes aim to perform one-repetition maximum (1RM). For this purpose, athletes are given three attempts with each exercise (9). Practicing this sport requires good muscle strength and power output. Therefore, the implementation of multi-joint exercise that involves a larger number of joints and muscle mass in motion seems to contribute to the improvement of these capabilities (5,7).

Resistance training enables different load control methodologies by using the variables of volume and intensity. The manipulation of these variables in the control of training overload causes adaptations in different musculoskeletal structures (16). According Swintons et al. (21), most powerlifting athletes use a training plan throughout a competitive cycle for better neuromuscular adaptation. However, there are few studies on RT programs using periodization methods. Fleck (8) indicates that most studies about RT periodization applied the traditional linear methodology during which an increase in intensity occurred while volume was decreased over the training time.

Given that the goal in powerlifting athletes is to realize a rapid increase in strength, the purpose of this study was to assess the effects of a 16-wk linear periodization RT macrocycle on the muscular strength gains in elite powerlifting athletes.

METHODS

Subjects

The sampling was intentionally selected by convenience, and classified as non-probability sampling due to the fact that subjects train in specialized centers. This study consisted of 9 Brazilian male elite athletes (mean ± SD: age, 34 ± 5 yrs; height, 175.2 ± 7.8 cm; body mass, 94.4 ± 16.7 kg, and experience in powerlifing, 7 ± 3 yrs). The classification proposed by Breuchue et al. (5) was used to select athletes among the body mass categories: 1 lightweight division (-67 kg) athlete; 6 athletes between 70-100 kg; and 2 athletes over 100 kg.

The inclusion criteria for participation in the study consisted of: (a) male athletes with at least 1 yr of powerlifting experience; (b) clinically healthy with physical conditions for competitive practice as indicated in a medical release form; (c) no medication that could influence the cardiovascular, immune, hormonal, and metabolic responses; and (d) at least 75% attendance in training.

The training sessions lasted 120 min. They were conducted 3 times·wk^{-1}. The exercises performed during the sessions were the bench press, squat, and deadlift. All experimental procedures were approved by the Research Ethics Committee on Human Research of São Judas Tadeu University under the protocol: 90.810/2012. All subjects were instructed about procedures and test protocols prior to signing a consent form.

Procedures

The organization of data collection was divided into 5 assessments (AS): AS1 – the initial assessment, before the start of the periodized training; AS2 – the end of the 1st 4-wk mesocycle

and the beginning of the 2nd mesocycle; AS3 - the end of the 2nd 4-wk mesocycle and the beginning of the 3rd mesocycle; AS4 - the end of 3rd mesocycle and the beginning of the 4th mesocycle; AS5 - the end of the 4th 4-wk mesocycle. All subjects performed the tests in the morning with a minimum interval of 24 hrs between sessions. When completing mesocycle 4, all subjects remained 6 days without training before the competition to re-establish their physical capabilities as a function of the cumulative gains of training before the competition (24).

Anthropometry

The subjects' body mass (BM) was measured using a Filizola® mechanical scale with a precision of 100 gm. Height was measured with a Sanny® stadiometer in mm. The athletes wore swimwear during the anthropometric assessment.

One Repetition Maximum Test (1RM)

The assessment of maximum strength was determined using the 1RM test for squat, bench press, and deadlift exercises in accordance with the protocol previously described by Wilson et al. (22). In the squat exercise, repetitions were considered valid when performed at a depth where the thighs reached a parallel position to the ground. During the bench press, it was necessary that the bar touched the pectoral region at the end of the eccentric phase and, then, the bar had to move through full extension of the elbow in the concentric phase of the movement. The deadlift exercise followed the same procedures of the squat exercise.

According to some studies (4,9) in literature, the use of support equipment such as suits and bench press shirt have been shown to influence strength gains. Thus, it is important to mention that the subjects were allowed to use belts and elastic bands around the wrists and knees as support equipment during training and assessments.

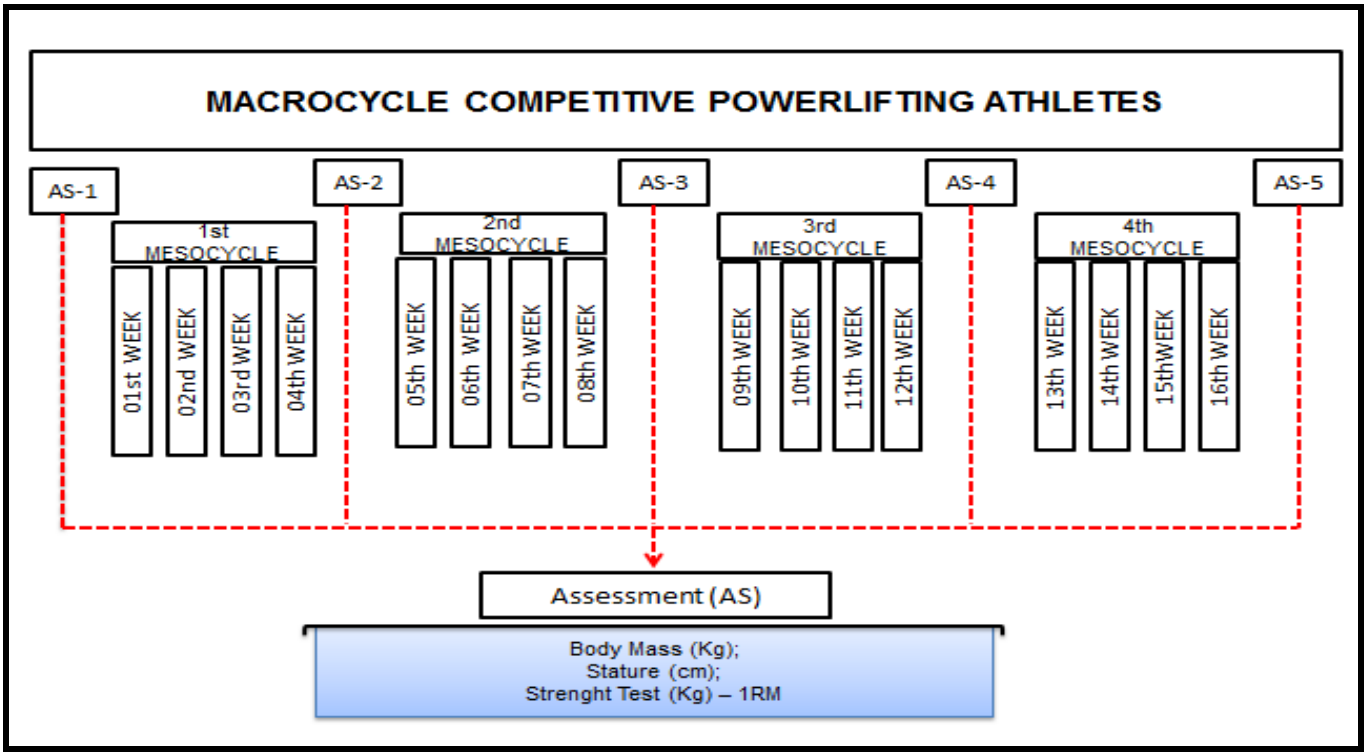

Figure 1. Assessment Protocols.

Period of Training

The subjects underwent a period of strength training mesocycles organized into 4 mth that consisted of 4 microcycles (4 wks in duration). The subjects were required to have a minimum frequency of training of 3 times·wk^{-1} in all mesocycles. Periodization was applied in a linear design, with a decrease in training volume (series vs. repetitions) and progressive increase in intensity (% 1RM) during the mesocycles (Table 1).

Table 1. Periodization of 4 Powerlifting Training Mesocycles.

MESO	MICRO	NºSER	NºREP	ID	%1RM	CT (Rep/MTH)
Meso 1	4	10	6	3-5 min	65%	240
Meso 2	4	8	4	3-5 min	75%	128
Meso 3	4	6	4	3-5 min	80%	96
	2	6	2	3-5 min	90%	
Meso 4	1	6	1	3-5 min	95%	34
	1	4	4	3-5 min	70%	
Mean ± SD	3 ± 2	7 ± 2	4 ± 2		80 ± 11	124 ± 86

MESO: mesocycle; **MICRO:** microcycle; **No. SER:** number of sets; **No. REP:** number of repetitions; **ID:** rest interval; **RM%:** percentage of 1 repetition maximum; **CT:** Workload (the product of sets x reps)

Determination of the Magnitude of the Effect of Training

The magnitude of the training effect was calculated using the mathematical formula that considers the final average value subtracted from the initial average value in relation to the variation of initial mean: [Pre-Post ES = Post-test mean – Pretest mean / Pretest SD]. In this study, the equation was:

ES = (mean AS5) – (mean AS1) / (standard deviation AS1)

The classification of the magnitude of the effect followed the method proposed by Rhea (19), for highly trained athletes, this phenomenon is known as effect size (ES).

Statistical Analyses

The sampling set was based on descriptive statistics (mean, standard deviation, median, and percentage). The Shapiro-Wilk and Levene's tests were applied to calculate sample normality. One-way ANOVA was used for comparing the average between assessments (AS1, AS2, AS3, AS4, AS5), and the Bonferroni post-test for possible differences between means. All statistical procedures were carried out using SPSS 17.0 software. Statistical significance was set at $P \leq 0.05$.

RESULTS

The results of this study revealed that the neuromuscular behavior in squat, bench press, and deadlift exercises showed significant increases (Table 2). It is notable that during 16-wk linear periodization RT program, there was a 30Δ% (31.7 kg) increase in muscle strength in the bench press exercise, 33Δ% (45.0 kg) increase in the squat exercise, and 76.9Δ% (101.7 kg) in the deadlift exercise.

Table 2. Mean and Standard Deviation of the Neuromuscular Profile of the Powerlifting Athletes.

	BP (kg)	SQ (kg)	DL (kg)	∑ (BP+SQ+DL)
AS1	104.4 ± 24.5	134.4 ± 26.5	132.2 ± 20.4	371.0 ± 61.7
AS2	121.6 ± 26.9[a]	160.0 ± 28.7[a]	158.9 ± 22.0	440.0 ± 70.1[a]
AS3	126.7 ± 35.8[a]	171.1 ± 50.5	172.2 ± 38.7	470.0 ± 117.0
AS4	137.5 ± 34.8[a]	175.0 ± 32.0[a]	187.2 ± 28.7[abd]	499.7 ± 88.3[a]
AS5	136.1 ± 20.9[a]	179.4 ± 37.2[a]	233.9 ± 14.1[abcd]	549.4 ± 63.7[ab]
AS5-AS1	**31.7***	**45.0***	**101.7***	**178.3***
Δ%	30.3	33.5	76.9	48.1

BP: Bench Press**; SQ:** Squat**; DL:** DeadLift**; ∑ BP+SQ+DL:** Sum**;* P≤0.05; a = relative AS1; b = for the AS2; C = compared to AS3; d = compared to AS4; *Difference between late vs. early AS5 AS1 (*t*-test).**

DISCUSSION

The purpose of this study was to determine the effect of 16 wks of periodized RT on strength gains of 9 elite powerlifting athletes. The results demonstrated a significant increase in muscle strength. At the end of the macrocycle, there was a significant increase of 179 ± 27 kg (Δ33.5%) in the squat exercise, 136 ± 21 kg (Δ30.3%) in the bench press exercise, and 233 ± 14 kg (Δ76.9%) in the deadlift exercise. This rapid increase in muscle strength is likely to be explained by the exercise-specific neuromuscular adaptations within the central nervous system, which resulted in an increase in the frequency of the firing of nerve impulses via the exercise-specific motor units. Thus, the increase in the excitation of the muscle motor neurons appears to have resulted in an increase in the number of muscle fibers without necessarily observing changes in muscle cross-sectional area (17).

According to Kamandulis et al. (11), muscular strength gains occur in powerlifting athletes with a training workload nearly 100% of 1RM. According to the authors, this application methodology optimizes the tension produced by the muscle in a short training period, allowing significant gains in strength with no damage in skeletal muscles. Thus, the improvement of neural factors can be understood in two ways. First, there is an improvement in intramuscular efficiency, particularly in regards to the patterns of neural recruitment that allow for an increase in agonist activity. Second, there is an improved coordination between agonist muscular movement and synergistic inhibition of the antagonist action (11).

This study highlights the athletes' strength development in the deadlift exercise (76.9%). It seems reasonable that the increase is a function of at least considerations: (1) the favored mechanics of the movement in comparison to other exercises that use lower limbs as the squat; (2) a larger number of joints and musculature involved in the movement; and (3) increased activation of the erector spinae muscles (14). Another factor that may explain the significant gains in such a short training period is the application of the high intensity and low volume training methodology. According to Zatsiorsky and Kraemer (24), this approach promotes overload tension, which may explain, in part, the behavior of the proposed neuromuscular adaptations.

Yet, it is important to point out that our results are still far below those presented by world-class athletes. According to Cleather (7), the average strength of powerlifting athletes for all categories of body mass in international (1995-2004) competitions was 312 ± 57 kg for the squat, 41 ± 20 kg for the bench press, and 302 ± 46 kg for the deadlift. The low gains in the strength of powerlifting athletes at national level compared to the data mentioned by Cleather (7) may be explained by the variation or periodization training.

Up to 2002, most studies (3,13,15) found in literature that evaluated the periodization of strength training used the traditional model of strength and power, which is characterized by a decrease in volume with an increase in training intensity (8). Yet, despite these findings, the study by Swinton and colleagues (21) found that powerlifting athletes are using the wave periodization methods for strength training. Numerous studies (1,6,16,18,23) have been carried out to elucidate the differences between the effects of the traditional and wave models of periodized RT. These studies demonstrate a trend towards improved performance when using wave periodization compared to linear periodization.

Nonetheless, more research is needed to better understand the effects of wave periodization and RT and why it appears to be more beneficial than linear periodization in powerlifting athletes. Lastly, other factors may be responsible for the low performance by the Brazilian athletes analyzed in this study (i.e., when compared to their international peers). The lack of professionalization of this sport as well as socioeconomic aspects of athletes and lack of technical training might be among the main reasons that could explain the scores.

CONCLUSIONS

The results of this study indicate that linear periodization training applied in powerlifting athletes seems to be relevant method of increasing muscle strength and improve performance. But, despite these findings, more studies are needed that involve different combination of the periodization models.

Practical Applications

The correct prescription of strength training with actual changes in performance and fitness practitioners from different modalities may help technicians and athletes in more effective control of periodization and training loads. This evolution can be of fundamental importance for individual sports, which have the division by categories of body mass as competitive criterion, and the athlete with the goal of increasing muscle strength.

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