FACTA UNIVERSITATIS
Series: **Physical Education and Sport** Vol. 5, N° 1, 2007, pp. 37 - 46

Scientific Paper

THE EFFECT OF DIFFERENT REST INTERVALS BETWEEN SETS ON THE TRAINING VOLUME OF MALE ATHLETES

UDC 796.42:542-058.833

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Abstract. *In order to examine the effects of different rest intervals between sets on the training volume completed during a workout, eleven male bodybuilders served as subjects (Mean SD, age= 22±1.4; mass=75±7.6 kg). All of the subjects performed a minimum of 3 strength workouts per week for a period of 2 years. Data collection took place over a period of four weeks with four testing session each week. During the first week, one repetition of the maximum (1RM) for the Bench Press (BP), Arm Curls (AC), Military Press (MP) and Leg Press (LP) were tested. Each of the next three weeks included four testing sessions (Saturday, Monday, Wednesday, Friday), during which four sets of exercises were performed with an 85% of 1RM load. During each testing session only one exercise was performed. During each testing session, exercises were performed with a 1, 2, or 5- minute rest interval between the sets. The training volume was defined as the number of repetitions completed over 4-sets and was measured for each rest condition and for each exercise. A statistical analysis was conducted separately for the training volumes in each exercise, and one-way repeated analyses of variance (ANOVA) with the Bonferroni Post Hoc demonstrated the significant differences between the training volume for each rest condition and exercise tested (P<0.05). The 5-minute rest between sets resulted in the highest training volume completed for all exercises, with the 2- and 1-minute rest conditions following in descending order. Our primary results support rest interval length as a strategy for increasing training volume, which is believed to enhance and stimulate greater strength and hypertrophy adaptations. Therefore, for the athletes that were involved in weight training programs in order to improve their maximum strength, it must be noted that rest interval length between sets is a critical component of a resistance-training program and this factor can lead to longer volumes of work.*

Key words: *rest interval, training volume, strength training*

Received November 20, 2006

1. INTRODUCTION

A resistance training program has become one of the most popular forms of exercise for improving physical fitness (Felck et al., 1977). Strength training programs can be designed to emphasize muscular strength, power, hypertrophy or endurance (Kraemer et al., 2002). The practice of weight lifting involves the organization of exercises based on the resistance (load) used, the number of times the weight is lifted (repetitions), the number of times a given repetition number is completed (sets), the recovery between sets (rest interval) and the summation of the total number of repetitions performed during a training session, multiplied by the resistance used (volume) (Roberges, & Robertts, 2000).

Manipulating any of these components will alter the specific training stimulus, and this manipulation of training variables is determined by the goals of the program and the needs of the athletes. Mistakes in any of these variables in the progression of a program could, in theory, result in an overtraining syndrome; therefore, the manipulation of these variables must be done correctly (Kreider et al., 1998).

Kraemer et al. (2002) have shown that rest interval length between sets has a critical role in designing strength-training programs and can be manipulated to fit the goal of a program. This factor significantly affects the metabolic (Kraemer et al., 1987), hormonal (Kraemer et al., 1993, 1991, 1990, 1987) and cardiovascular (Felck, 1988) responses to an acute bout during resistance exercise, as well as the performance of subsequent sets (Kraemer et al., 1997), and training adaptations (Pincivero et al., 1997; Robinson et al., 1995).

Training volume is a summation of the total number of repetitions performed during a training session multiplied by the resistance used (Rahimi, 2005). This factor has been shown to affect neural (Hakkinen et al., 1987, 1988), hypertrophy (Dolezal, & Potteiger, 1988), metabolic (Collins, et al., 1986), and hormonal (Gotshalk et al., 1997; Kraemer et al., 1993; Mulligan et al., 1996) responses and subsequent adaptations to resistance training.

Although previous research has studied the effects of different rest interval lengths on training volume, only during squats or bench presses, and has produced controversial results, these studies have shown the rest interval between sets affects (Kraemer et al., 1997; Rahimi, 2005; Robinson et al., 1995; Willardson, & Burkett, 2005) and/or less effective (Larson, & Potteiger, 1997; Weir et al., 1994) volume training completed during a workout.

Resistance-trained athletes, such as bodybuilders or power-lifters, must perform exercises at maximal or near maximal intensities with repeated efforts in order to enhance muscular strength and hypertrophy; rest interval length between sets for these athletes may be a critical issue for maximizing performance, and as it has been shown, greater hypertrophy is associated more with high-volume, multiple-set programs, as compared to low-volume programs (Kraemer et al., 2002).

The results of these studies suggest that the repeatability of performance over time and multiple sets is dependent on the amount of rest between sets and the load being lifted. However, whether recovery is similar for other commonly used free-weight exercise such as; the Bench Press, Arm Curls, Military Press and Leg Press, is not known.

However, to our knowledge, the effectiveness of an 85% 1RM load, and the fact that it is recommended as a favorable load for bodybuilders and powerlifters in order to enhance muscular strength and hypertrophy (Hakkinen et al., 1987, 1988), in addition to the effect of 1, 2, or 5-min rest intervals on the military press, bench press, arm curl, and leg press training volume completion over 4 sets with an 85% 1RM load, has not been reported. Therefore, the purpose of this study was to investigate the effects of different rest intervals between sets on the training volume completed over 4 sets with an 85% of 1RM load during a workout for bodybuilders.

2. Methods

Subjects

Eleven male bodybuilders volunteered for this study (Mean ± SD for age = 22±1.4 years; mass=75±7.6 kg). The subjects had a minimum of 3 strength workout per week of bench presses, arm curls, leg presses and military presses for the previous 2 years, and none of the subjects had any experience with such training styles before the study. The subjects signed a human subject's informed consent form before participating in this study and completed a medical history questionnaire in which they were screened for any possible injury or illness.

Experimental approach to the problem

To test the hypothesis that there is a significant difference in training volume completed during a workout involving the bench press, arm curls, leg press and military press due to different rest intervals between sets, and the volume completed during a workout in these exercises were compared for each rest interval length (1, 2, and 5-minute rest).

Data collection

Data was collected four times (Saturday, Monday, Wednesday and Friday) a week for 4 weeks. The subjects were required to warm up prior to each testing session, and the warm-up consisted of 4 minutes of low intensity exercise on a cycle ergometer. Then the subjects performed 1 set of 8 repetitions and 1 set of 5 repetitions at 50 and 70% of their estimated 1RM respectively. The warm-up procedure was held constant throughout all of the testing session. In the first week, 5 minutes after the warm-up, 3-5 1RM attempts were performed with 4 minutes of rest between each attempt. After each repetition, the weight was increased by 2.5-10 kg for each repetition until failure; the final weight lifted was the 1RM load (Cotterman, et al., 2005). The same procedures were carried out for 1RM testing on the bench press, military press, arm curls and leg press exercise on each type of equipment, with a one-day break between the 1RM tests (Sharkely, 1990).

After the determination of the 1RM in the BP, AC, MP and LP, the 85% of 1RM loads selected represented the load used in testing sessions. During the next 3 weeks, 4 sets of bench presses, leg presses, arm curls and military presess with 85% of 1RM were performed with a 1, 2, and 5- minute rest interval between sets. The subjects were told to try to execute the maximum possible repetition in each set, until they reached a functional incapacity to surpass the resistance offered. Four testing sessions were conducted each week (Sat., Mon., Wed. and Fri.) (see Table 1).

Table 1. Testing program

Week	Day	Bench Press	Arm Curls	Military Press	Leg Press
2	Saturday	4 sets (85%1RM), 1-Minute rest			
	Monday	–	4 sets (85%1RM), 2-Minute rest		
	Wednesday	–	–	4 sets (85%1RM), 5-Minute rest	
	Friday	–	–	–	4 sets (85%1RM), 2-Minute rest
3	Saturday	4 sets (85%1RM), 2-Minute rest			
	Monday	–	4 sets (85%1RM), 5-Minute rest		
	Wednesday	–	–	4 sets (85%1RM), 1-Minute rest	
	Friday	–	–	–	4 sets (85%1RM), 1-Minute rest
4	Saturday	4 sets (85%1RM), 5-Minute rest			
	Monday	–	4 sets (85%1RM), 1-Minute rest		
	Wednesday	–	–	4 sets (85%1RM), 2-Minute rest	
	Friday	–	–	–	4 sets (85%1RM), 5-Minute rest

An attempt was considered successful when that movement was completed through a full range of motion without deviation from the proper technique and form. Spotters were present to provide verbal encouragement and safety for the subjects. To ensure that all of the subjects were moving at approximately the same velocity for each repetition, each set was timed using a handheld stopwatch. The spotter called out a cadence for the eccentric and concentric phase of each repetition. The repetition velocity consisted of a 2-second eccentric phase followed by a 1-second concentric phase (Kraemer et al., 2002).

Statistical analyses

The results were analyzed with the SPSS 12.0 statistical software. The training volumes from the different sessions for each exercise were compared using a one-way analysis of variance (ANOVA) with repeated measures. The alpha level was set at 0.05 in order for a difference to be considered significant. When a significant effect was detected, a pairwise comparison of the sessions was carried out using Bonferroni's post hoc test to identify significant differences between sessions.

3. RESULTS

The training volumes completed for the bench press, arm curls, military press and leg press were significantly different between the 1- and 5-minute rest conditions and between the 2- and 5-minute rest conditions (P<0.05, see Table 2, Fig.1-4), and there is no significant differences between the 1- and 2-minute rest conditions for any of the exercises; the training volumes for the military press in the third set were significantly different between the 1- and 2-minute rest conditions (P=0.04). As has been shown in Table 2, there was a significant decline in the training volume completed from set 2 to set 3 and set 4 (P=0.05), suggesting that the protocol did induce fatigue, and the need for a longer recovery period increased.

Table 2. Mean (±SD) values for repetitions completed.

Exercise	Rest Time	Set 1	Set 2	Set 3	Set 4	Total
Bench Press	1-M (W2, Sat.)	8.45± 0.52	5.54± 0.68*	3.27± 0.64*	2.36± 0.5*	4.90± 2.44*
	2-M (W3, Sat.)	8.54± 0.52	6.09± 0.83	3.9 ± 0.83	2.45± 0.52£	5.25± 2.42£
	5-M (W4, Sat.)	8.36± 0.67	6.72± 0.9 *	5.36± 0.8*£	3.81± 0.6*£	6.06± 1.84*£
Arm Curls	1-M (W4, Mon.)	7 ± 0.77	6 ± 0.77	4.36± 1.2*	3.63± 1.2*	5.25± 1.65*
	2-M (W2, Mon.)	7 ± 0.77	6.27± 0.78	4.9 ± 0.7	3.63± 0.92£	5.45± 1.51
	5-M (W3, Mon.)	7 ± 0.83	6.27± 0.64	5.3 ± 0.67*	4.81± 0.75*£	5.88± 1.12*
Military Press	1-M (W3, Wed.)	6.18± 0.75	4.45± 0.52*	2.09± 0.53*‡	2.27± 0.46*‡	3.95± 1.6*
	2-M (W4, Wed.)	6 ± 0.44	4.54± 0.52£	3.54± 0.52£‡	3.09± 0.7‡	4.29± 1.24£
	5-M (W2, Wed.)	6.18± 0.40	5.54± 0.52*£	4.36± 0.64*£	3.45± 0.68*	4.95± 1.18*£
Leg Press	1-M (W3, Fri.)	6.45± 0.52	5.18± 0.6	4 ± 0.89*	2.45± 0.53*	4.52± 1.62*
	2-M (W2, Fri.)	6 ± 0.44	5.54± 0.68	4.27± 0.64£	3.45± 0.52£	4.81± 1.16£
	5-M (W4, Fri.)	6.09± 0.30	5.72± 0.41	5.36± 0.5*£	4 ± 0.44*£	5.29± 0.9*£

(1-M;1-Minute rest, 2-M; 2-Minute rest, 5-M; 5-Minute rest,W2; Week-2; W3; Week-3, W4; Week-4, Sat.; Saturday, Mon.; Monday, Wed.; Wednesday, Fri.; Friday,)
* Significant difference between 1- and 5-minute rest conditions ($p < 0.05$).
£ Significant difference between 2- and 5-minute rest conditions ($p < 0.05$).
‡ Significant difference between 1- and 2-minute rest conditions ($p < 0.05$).

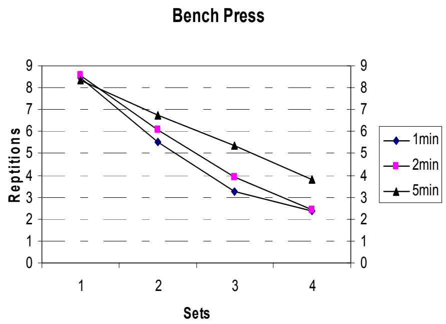

Fig. 1. Average values related to the number of repetitions performed in four sets of the Bench Press exercise with different recovery periods between sets.

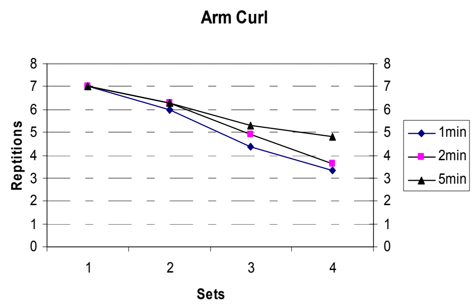

Fig. 2. Average values related to the number of repetitions performed in four sets of the Arm Curl exercise with different recovery periods between sets.

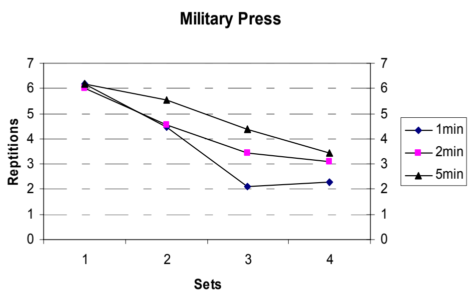

Fig. 3. Average values related to the number of repetitions performed in four sets of the Military Press exercise with different recovery periods between sets.

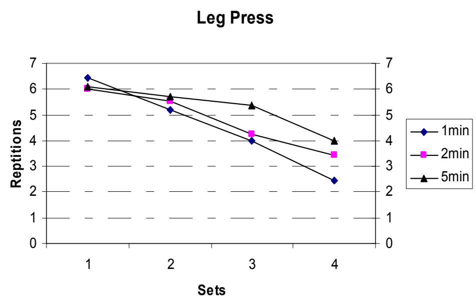

Fig. 4. Average values related to the number of repetitions performed in four sets of the Leg Press exercise with different recovery periods between sets.

4. DISCUSSION

The purpose of this study was to investigate the effects of different rest intervals between sets on the training volume of bodybuilders. The results demonstrated that a 5-minte rest interval between sets may be responsible for optimal recovery and a significantly increased total training volume. Also, there was no significant difference in training volume completed between the 1- and 2-minute rest conditions ($p=0.185$). These results are supported by Willardson et al. (2005), and Rahimi (2005), who have demonstrated that the 5-minute rest condition resulted in the highest volume completed, followed in descending order by the 2- and 1-minute rest conditions, and concluded that the ability to perform a higher volume of training with a given load may stimulate greater strength adaptations.

The results of the current study were different from those demonstrated by Kraemer et al. (1997), who found that when subjects rested for 3 minutes between sets, they were able to complete all 10 repetitions over 3 sets of the bench press with a 10 RM load. In the current study, the subjects failed to complete maximum repetitions over 4 sets of the bench press, military press, arm curls and leg press with an 85% of a 1RM load; even when resting 5 minutes between sets, the repetitions decreases from set 1 to set 4 (see Table 2; Fig. 1-4). These differences in the results may be accounted for by the differences in the training status of the subjects and the resistance used.

The data in the present investigation are in agreement with several other studies involving the use of 3 different rest intervals on the squat volume (Kraemer et al., 1987; Larson & Potteiger, 1997; Rahimi, 2005; Willardson & Burkett, 2005). Although Robinson et al. (1995) demonstrated that a 3-minute rest interval resulted in higher training volume, a longer rest interval may produce an even higher training volume and, consequently, greater strength gains.

The results demonstrated that, as the rest interval between sets increased, the total number of repetitions completed also increased. The results of the present investigation may be attributed to the energy system used during short-term exercises such as the bench press, leg press, arm curls and military press that performed over 4 sets with an 85% of 1RM load. The exercises performed in the present study were executed in a time frame during which anaerobic glycolysis and the phosphasion systems would predominate.

When lifting a submaximal amount of resistance, the slow and fast-twitch muscle fibers are recruited, but at first, the slow-twitch muscle fibers exert force and when the slow-twitch muscle fibers become progressively fatigued, the fast-twitch muscle fibers continue to produce sufficient force. Finally, when all of the available muscle fibers are fatigued and cannot produce sufficient force, the set ends (Sale, 1987; Zatsiorsky, 1995).

When considering the rest interval between sets, slow twitch muscle fibers would require a shorter recovery due to their oxidative characteristics, whereas fast twitch muscle fibers would require a longer recovery due to their glycolytic characteristics (Weiss, 1991). Because fast-twitch muscle fibers rely heavily on anaerobic glycolysis for their energy production, these fibers would accumulate higher levels of lactic acid during high intensity exercise. The accumulation of lactic acid has been shown to lower intracellular pH through the dissociation of hydrogen ions (H^+), which results in muscle fatigue (Jones et al., 1983; Taylor et al., 1990).

Several researchers have suggested that "lactic acid" is the source of H^+, which is inaccurate. Gevers et al. (1977) first drew attention to the very important possibility that protons might be generated in significant quantity in the muscle by metabolic processes other than the lactate dehydrogenase reaction. He suggested that the major source of protons was the turnover of ATP produced via glycolysis, and many researchers (Busa et al., 1999; Corey, 2003; Harmer et al., 2000; Hochachka & Mommsen, 1993; Kowalchuk et al., 1988; Robergs et al., 2005) supported Gevers' idea that metabolic acidosis resulting from glycolysis is primarily due to ATP hydrolysis by myosin ATPase that yields ADP, Pi, and H^+.

According to these authors, only ADP and Pi are recycled via glycolysis to produce ATP, leaving H^+behind to accumulate within the cytosol. It is only when the exercise intensity increases beyond the steady state that there is a need for greater reliance on ATP regeneration from glycolysis and the phosphagen system.

The ATP that is supplied from these non-mitochondrial sources and is eventually used to fuel muscle contraction, which increases proton release and causes acidosis during intense exercise. Lactate production increases under these cellular conditions to prevent pyruvate accumulation and supply the NAD^+ needed for phase 2 of the glycolysis (Robergs et al., 2005). Thereby, when the rate of H^+ production exceeds the rate of the capacity to buffer or remove protons from skeletal muscle, or when there is not enough time to buffer or remove H^+production, metabolic acidosis ensues and results in muscle fatigue. Short rest intervals of 1 minute or less have been shown to significantly increase lactic acid levels during heavy strength training exercise (Kraemer et al., 1987).

The time needed for lactic acid clearance following high-intensity exercise has been shown to be 4-10 minutes (Jones et al., 1983). In the current study, the 5-minute rest condition provided enough time for the H^+ uptake and delayed fatigue, which allowed subjects to complete a higher volume of training, unlike the 1- and 2-minute rest conditions.

The current study demonstrated a dose-response relationship between the amount of rest between sets and the volume of the training completed. However, it is recommended that future researchers considers the investigation of longer rest intervals to detect the point that might cause a decrease in the training volume completed, that to the present day has not been reported.

5. CONCLUSIONS

The strength training program is an important component of health-and performance-related fitness programs. When designing a strength training program, to optimize training adaptation, the overload principle must be used; therefore, for muscular strength, hypertrophy and power, the specific nature of overload that favors strength and power or endurance is manipulated by altering the number of repetitions, the resistance lifted, and the duration of the recovery (Robergs & Roberts, 2000). Therefore, in this study, the rests between sets is manipulated and it has been shown that a 5-minute rest interval between sets allowed for the highest volume to be completed when athletes trained with an 85% of 1RM load.

It has been shown that the ability to perform a higher volume of training with a given load may stimulate greater strength and hypertrophy adaptations (Rahimi, 2005; Robinson et al., 1995). Therefore, power lifters and bodybuilders must become aware that training with submaximal amounts of resistance necessitated a 5-minute rest between sets for recovery and the prevention of fatigue; thereby, with this rest interval length, athletes are able to perform a higher volume of training that, as mentioned above, may stimulate greater strength and hypertrophy adaptations.

REFERENCES

1. Baechle, T.R., Earle, R.W., & Wathen, D. (2000). *Resistance training*. Champaign IL: Human Kinetics, 395-425.
2. Busa, W. B., & Nuccitelli, R. (1999). Metabolic regulation via intracellular PH. *Am. J. Physiol. Regul. Integr. Comp. Physiol*., 246, R409-R438.
3. Collins, M.A., Hill, D.W., Cureton, K.J., & DeMello, J.J. (1986). Plasma volume change during heavy resistance weight lifting. *Eur. J. Appl. Physiol*., 55, 44- 48.
4. Corey, H. E. (2003). Stewart and beyond: new models of acid-base balance. *Kidney International*, 64, 777– 787.
5. Cotterman, M. L., Darby, L. A., & Skelly, W. A. (2005). Comparison of muscle force production using the smith machine and free weights for bench press and squat exercises, *J. Strength and Cond. Res*., 19(1), 169-176.
6. Dolezal, B.A., & Potteiger, J.A. (1988). Concurrent resistance and endurance training influence basal metabolic rate (BMR) in non-dieting individuals. *J. Appl. Physiol*., 85, 695-700.
7. Fleck, S.J. (1988). Cardiovascular adaptations to resistance training. *Med. & Sci. Sports & Exe*., 20, S146-S151.
8. Fleck, S.J., & W. J. (1977). *Kraemer, Designing resistance training programs*. Champaign IL: Human Kinetics.
9. Gevers W. (1977). Generation of protons by metabolic processes in heart cell. *J. Mol. Cell Cardiol*., 9, 867-874.

10. Gotshalk, L.A., Loebel, C.C., Nindl, B.C., Putukian, M., Sebastianelli, W.J., Newton, R.U., Hakkinen, K., & Kraemer, W.J. (1997). Hormonal responses to multiset versus single-set heavy-resistance exercise protocols. *Canadian J. Appl. Physiol*., 22, 244-255.
11. Hakkinen, K., Komi, P.V., Alen, M., & Kauhnen, H. (1987). EMG, muscle fibre and force production characteristics during a 1 year training period in elite weightlifters. *Eur. J. Appl. Physiol*., 56, 419-427.
12. Hakkinen, K., Pakarinen, A., Komi, P.V., Alen, M., & Kauhnen, H. (1988). Neuromuscular and hormonal adaptations in athletes to strength training in tow years. *J. Appl. Physiol*., 65, 2406- 2412.
13. Harmer, A. R., Mckenna, M.J., Sutton, J. R., Snow, R. J., Ruell, P. A., Booth J., Thompson, M. W., Macky, N. A., Stahis, C. G., Creameri, R. M., Cary, M. F., & Eager, D. M. (2000). Skeletal muscle metabolism and ionic adaptations during intense exercise follwing sprint training in humans. *J. Appl. Physiol.*, 89, 1793-1803.
14. Hochachka, P. W., & Mommsen, T. P. (1993). Protons and anaerobiosis. *Science*. 219, 1391-1397.
15. Jones, N.L., McCartney, M.R., & McComas, A.J. (1986). *Human muscle power*. Champaigin IL: Human Kinetics, 215-238.
16. Kowalchuk, J.M., Heigenhauser, G.J.F., Lindinger, M.I., Sutton, J.R., & Jones, N.L. (1988). Factors influencing hydrogen on concentration in muscle after intense exercise. *J. Appl. Physiol*., 65, 2080-2089.
17. Kraemer, W.J., Adams, K., & Fleck, S.J. (2002). Progression models in resistance training for healthy adults. *Med. & Sci. in Sports & Exe*., 34, 364- 380.
18. Kraemer, W.J. (1997). A series of studies. The physiological basis for strength training in American soccer: Fact over philosophy. *J. Strength and Cond. Res*., 11, 131-142.
19. Kraemer, W.J, Fleck, S.J., Dziados, J.E., Harman, E.A., Marchitelli, L.J., Gordon, S.E., Mello, R., Frykman, P.N., Koziris, .LP., & Triplett, N.T. (1993). Changes in hormonal concentrations after different heavy-resistance exercise protocols in women. *J. Appl. Physiol*., 75, 594- 604.
20. Kraemer, W.J, Gopdon, S.E., Fleck, S.J., Marchitelli, L.J., Mello, R., Dziados, J.E., Friedl, K., Harman, E., Maresh, C., & Fry, A.C. (1991). Endogenous anabolic hormonal and growth factor responses to heavy-resistance exercise males and females. *Int. J. of Sports Med*., 12, 228- 235.
21. Kraemer, W.J., Marchitelli, L., Gordon, S.E., Harman, E., Dziados, J.E., Mello, R., Frykman, P., McCurry, D., & Fleck, S.J. (1990). Hormonal and growth factor responses to heavy-resistance exercise protocols. *J. Appl. Physiol*., 69, 1442-1450.
22. Kraemer, W.J, Noble B.J., Clark M.J., & Culver B.W. (1987). Physiologic responses to heavy-resistance exercise with very short rest periods. *Int. J. Sports Med*., 8, 247-252.
23. Kreider, R.B, Fry, A.C., & O'Tool, M.L. (1998). Overtraining in sport. Champaign IL: Human Kinetics, 73-74.
24. Larson, G.D., & Potteiger, J.A. (1997). A comparison of three different rest intervals between multiple squat bouts. *J. Strength Cond. Res*., 11(2), 115-118.
25. Mulligan, S.E., Fleck, S.J., & Kraemer, W.J. (1996). Influence of resistance exercise volume on serum growth hormone and cortisol concentration in women. *J. Strength Cond. Res.,* 10, 256-262.
26. Pincivero, D.M., Lephart, S.M., & Karunakara, R.G. (1997). Effects of rest interval on isokinetic strength and functional performance after short term high intensity training. *British J. Sports Med.,* 31, 229-234.
27. Rahimi, R. (2005). Effect of different rest intervals on the exercise volume completed during squat bouts. *J. Sports Sci. & Med*., 4, 361-366.
28. Robergs, R.A., Ghiasvand, F., & Parker, D. (2004). Biochemistry of exercise - induced metabolic acidosis. *Am. J. Physiol*., 287, R502-516.
29. Robergs, R.A., & Roberts, S.O. (2000). *Fundamental Principles of Exercise Physiology: For Fitness, Performance and Health.* Dubuque: McGraw-Hill
30. Robinson, J.M, Stone, M.H, Johnson, R.L, Penland, C.M, Warren, B.J., & Lewis, R.D. (1995). Effects of different weight training exercise/rest intervals on strength, power, and high intensity exercise endurance. *J. Strength Cond. Res*., 9, 216-221.
31. Sale, D.G. (1987). Influence of exercise and training on motor unit activation. *Exe. & Sport Sci. Rev*.,15, 95-151.
32. Sharkely, B.J. (1990). *Physiology of fitness*. Champaign IL: *Human Kinetics*, 84-85.
33. Tafaletti, J.G. (1991). Blood lactate: biochemistry, laboratory methods and clinical interpretation. *Critical Rev. Clin. Laboratory Sci.,* 28, 253–268.
34. Taylor, A.W., Gollnick, P.D., Green, H.J., Ianuzzo, C., Noble, E.G., Metivier, G., & Sutton, J.R. (1990). *Biochemistry of exercise VII*. Champaign IL: Human Kinetics*,* 333-339.
35. Weir, J.P, Wagner L.L., & Housh, T.J. (1994). The effect of rest interval length on repeated maximal bench presses. *J. Strength Cond. Res*., 8, 58-60.
36. Weiss, L.W. (1991). The obtuse nature of muscular strength: The contribution of rest to its development and expression. *J. Appl. Sport Sci. Res*., 5, 219-227.
37. Willardson, J.M., & Burkett, L.N. (2005). A comparison of 3 different rest intervals on the exercise volume completed during a workout. *J. Strength Cond. Res*.,19, 23-26.
38. Zatsiorsky, V.M. (1995). *Science and practice of strength training*. Champaign IL: Human Kinetic*s,* 85-107.

EFEKAT RAZLIČITIH INTERVALA ODMORA IZMEĐU SETOVA NA TRENAŽNI VOLUMEN MUŠKIH SPORTISTA

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Za istraživanje efekata različitih intervala odmora između setova na trenažni volumen izvršenih u toku treninga, posluzilo je 11 bodibildera (Mean ±SD, starosti = 22 ±1.4 godine; mase = 75±7.6 kg). Svi ispitanici izvodili su minimum 3 treninga nedeljno za prethodne 2 godine. Dobijeni podaci sakupljani su u periodu od četiri nedelje na 4 testiranja svake nedelje. U prvoj nedelji testiran je (1RM) u Bench Press (BP), Arm Curl (AC), Millitary Press (MP) i Leg Press (LP). Svake od sledeće tri nedelje izvršena su četiri testiranja (subota, ponedeljak, sreda i petak), u toku kojih četiri seta vežbanja je izvedeno sa 85% od 1RM opterećenja, a na svakom testiranju izvođeno je samo jedno vežbanje. U toku svakog testiranja, vežbe su bile izvođene sa 1,2 ili 5 – minutnim intervalom odmora između setova. Trenažni volumen koji se definiše kao broj ponavljanja izvršenih u 4 seta, je meren za svaki uslov odmora i za svako vežbanje. Statistička analiza bila je sprovedena odvojeno za trenažne volumene za svako vežbanje. Univarijantna analiza varijanse (ANOVA) sa Boniferroni Post Hocs pokazuje značajnu razliku između trenažnih volumena za svaki uslov odmora i testirano vežbanje (p<0,05). Petominutni odmor između setova rezultira u najvišem trenažnom volumenu izvršenom za sva vežbanja, sledeći opadajući niz sa dvominutnim i jednominutnim uslovima odmora. Naš primarni rezultat podržava produženi interval odmora kao strategiju za povećanje trenažnog volumena za koji se veruje da menja i stimuliše veću snagu i hipertrofičnu adaptaciju. Prema tome, sportisti koji su uključeni u program treniranja dizanjem tegova za poboljšanje maksimuma snage moraju biti upoznati da trajanje intervala odmora između setova je kritična komponenta za program treniranja sa opterećenjem i ovaj faktor može rukovoditi dugotrajnim volumenom rada.

Ključne reči*: interval odmora, volumen treninga, trening snage*