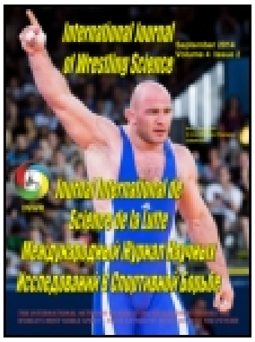

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The Effects of Two Different Resistive Loading Patterns on Strength, Hypertrophy, Anaerobic Power and Endurance in Young Wrestlers

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THE EFFECTS OF TWO DIFFERENT RESISTIVE LOADING PATTERNS ON STRENGTH, HYPERTROPHY, ANAEROBIC POWER AND ENDURANCE IN YOUNG WRESTLERS

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ABSTRACT

The present study investigates the effects of two types of loading patterns in resistance training. A double-pyramid loading pattern (DP) and a reverse step loading pattern (RS) were employed to study their effects on selected physiologic abilities of young wrestlers. For this purpose, 22 wrestlers volunteered to participate. Subjects (age 17.30± 2.42 years; height 170.41± 6.14 cm; weight 72.29±13 Kg; and BF% 12.39± 7.39) had a history of at least 6 months of wrestling training. The subjects were randomly divided into 3 groups; a control group (n=8), and two resistance training groups: a group using the DP loading pattern (n=7); and a group using the RS loading pattern (n=7). The subjects trained for 8 weeks using two selected loading patterns. In DP, subjects trained with 4/80%, 3/85%, 2/90%, 1/95%, 1/95%, 2/90%, 3/85%, 4/80%. In RS, subjects trained with 2/90%, 10/70%, 15/60%, 2/90%, 10/70%, 15/60%. To study the variables, the ANOVA test and Tukey's post-hoc test were used. The results of a 1RM strength test did not indicate any significant differences between the two training groups on upper and lower body muscles; however, this difference was significant for the control group ($P \geq 0.05$). In a muscular endurance test for lower body muscles, the difference between all 3 groups was significant, and this significance was greatest for the RS group; however, the difference between the two training groups of DP and RS in the upper body was not significant ($P \geq 0.05$). The results of muscular mass indicated that no significant difference existed between the training groups. However, the difference between two groups of training and the control group was significant ($P \leq 0.05$). Studying the statistical test for "leg-power" indicated that no significant difference existed between the 3 groups; however, the difference between two groups of DP and RS was significant ($P \leq 0.05$). In conclusion, it seems that both training models, were suitable for increasing strength, endurance, muscle mass and muscular power; and almost have similar benefit in physiologic factors of the athletes. However if the aim is increasing strength along with increasing muscular endurance, the RS model is more appropriate.

Keywords: Wrestling; Resistance training; Double-pyramid loading pattern; reverse step loading pattern.

INTRODUCTION

Coaches and sport scientists attempt to identify better ways to gain physical fitness and maximal sport performance. For this reason, they have been experimentally testing the many different methods employed by coaches for conditioning their athletes. Competitive wrestling activity is extremely dynamic in nature and one of the most physically and metabolically challenging events in international level competition (18). Nowhere else in sports is there the need for total body strength is as evident as it is in wrestling (18). In wrestling; strength, anaerobic power and endurance have critical roles for success (12, 14, 22). Also, because of weight classification in wrestling, wrestlers and their coaches attempt to recognize training methods to achieve the best strength and power with the lowest increase in weight. At the same time, muscular endurance is necessary for performing techniques and also, for attack and defense-related fatigue tolerance which must be considered in the planning of the training program.

There is no full agreement between sport scientists and coaches regarding the optimal amount of resistance used in resistance training for optimum performance (22). Weight training is very important in wrestling and other combat sports, because strength, anaerobic power and endurance are all influenced by weight training. Some studies have reported that an increased training volume does not produce any performance change in Olympic lifts during short-or long-term training periods (9, 11). It seems that when a given optimal volume is reached, a further increase in training volume does not produce more gains and can even lead to reduced performance (10). Because varying models of resistance training exist, it seems prudent to examine these

protocols to determine if any one of these methods is more effective at eliciting strength gains while mimimizing gains in body weight.
Most previous research has only studied the differences in periodized and nonperiodized programs (4) and less attention was directed towards the different resistive loading patterns. Performing techniques and skills in high level wrestling requires great strength and power, especially for techniques that require lifting the opponent. A wrestler should have the ability for pushing and pulling opponent in the 6 minutes of the match and meanwhile, performing techniques as well as possible. According to these statements, for success, a wrestler must have strength, power and endurance in high amounts. Another important factor in the training schedule for wrestlers is that determination gains in the amount of hypertrophy must be determined.

The double pyramid consists of two pyramids, one inverted on top of the other. Most proponents of this pattern suggest that the last sets, are meant to improve power. On the contrary, because the fatigue may impair rapid recruitment of the fast-twitch fibers, the outcome of the last sets of this loading pattern will be development of muscle hypertrophy rather than power. In the reverse step loading, the load decreases rather than increases from step to step. Performance improvements are possible only when training capabilities have increased. Endurance improvements are much better achieved by step loading (2).

In view of these considerations, we evaluated the effects of two different loading patterns [double pyramid (DPLP) & reverse step (RSLP)] on muscle strength and hypertrophy, anaerobic power and endurance in wrestlers to determine how these training systems influence the physiologic factors in young wrestlers.

METHODS

Twenty-two young male wrestlers (age, 17.30 ± 2.42 yrs, height, 170.41 ± 6.14 cm, weight, 72.29 ± 13.18 kg, BF%, 12.36 ± 7.39 %) volunteered as subjects for the study. They were verbally informed of the procedures of the investigation and subsequently signed an approved consent form in accordance with the guidelines of the University Institutional Review Board for use of human subjects. After primary measurements, all subjects performed training with the assigned loading patterns (double pyramid & reverse step) for eight weeks. Before the test and training sessions, the subjects performed a warm-up which included 10 min of general warm-up and stretching exercises for the whole body muscles, then for a specific warm-up subjects performed five repetitions with 30% (2 mins rest).
Dynamic muscular strength test: We used of 1-RM method for calculating maximum strength as described by Mc Guigan et al (2006), However, before performing the tests, and after the general warm up, all subjects completed five reps with 30% (2 min rest), four reps with 50% (2 min rest), three reps with 70% (3 min rest), and one rep with 90% (2 min rest) performed for special warm up. After performing the lift with 90% of 1-RM, for calculating 1-RM load in the next attempts added 2.5kg after each success effort and with 4 min rest.
Dynamic muscular endurance test: After determining subject’s 1-RM, we separately calculated 60% of 1-RM for each movement and asked subjects to perform maximum reps. Performed reps were noted as their local muscular endurance record.
Static muscular leg strength test: This test performed using a back and leg dynamometer. Subjects were placed on the apparatus platform and flexed their knees to 130-140 degrees with a fixed trunk. Each subject gripped the dynamometer’s handle with internal rotation of the hand, and the chain lenghth was so the handle was gripped at the subject’s mid-thigh. When performing this test, the subjects were told not to use back movement, but to extend the knees slowly and with maximum force. Each subject repeated three trials of test and the best record was noted. Rest interval between trials was one min.
Static muscular hand gripe strength and endurance test: The purpose of this test is to measure the maximum isometric strength of the hand and forearm muscles. The subject holds the dynamometer in the hand to be tested, with the arm at right angles and the elbow by the side of the body. The handle of the dynamometer is adjusted if required, while the handle should set on middle of four fingers. When ready, the subject squeezes the dynamometer with maximum isometric effort. No other body movement was allowed. The subject should be strongly encouraged to give a maximum effort. Primary effort was noted as strength record and the record in end of one min effort was noted as the endurance record.
Vertical jump test for measuring lower extremity muscles power: Subjects lower extremity power was measured by the Sargent jump test using the vertical height jump to calculate mean and peak power (3).
Muscle hypertrophy measurement: For measuring muscle hypertrophy we used of methods that described by Housh (13) and Frisancho (8), for thigh muscle (quadriceps and hamstring muscles) and arm muscles, respectively.
Skin fold measurement: methods described by Lohman (21) were used for measurement skin fold thickness and limb circumferences in special area of body.

Statistical analyses. Data were analyzed using SPSS 17. In order to describe the general characteristics of the subjects, the descriptive statistics (mean & standard) were used. For studying differences between the variables, ANOVA, and TUKEY's post-hoc test were used. A Student's paired t-test was conducted for determining the difference in pre to post-protocols measures. Independent sample t-tests were performed for determining differences between the two protocols.

RESULTS

Descriptive characteristics of the subjects are presented in Table 1.

TABLE 1. Descriptive characteristics of the subjects

Descriptive characteristics	**DP group (n =7)**	**RS group (n=7)**	**C group (n=8)**
Height (cm)	173.14 ± 6.06	176.14 ± 4.37	168.25 ± 0.3
Weight (kg)	74.28 ± 18.19	75.57 ± 11.67	69.93 ± 13.54
Age (year)	17.57 ± 2.82	16.85 ± 1.46	17.5 ± 3.29
Body fat (%)	12.43 ± 6.45	12.86 ± 7.53	11.20 ± 7.65

The relative training load, volume, and volume load between the two protocols were equated. Strength (bench and leg press) measures before and after loading protocols are given in Table 2. The results of 1RM strength test did not indicate any significant differences between the two training groups on upper body muscles (bench-press); and lower body muscles (leg-press); however, this difference was significant for the control group.

TABLE 2. The mean (SD) strength from pre and post loading protocols and % change in each of these variables.

	Pre protocol	Post protocol	Change in mean (SD)	% change
Bench press (kg)				
DP protocol	62.85 (19.27)	81 (19.11)	18.14 (8.05)	29%*****
RS protocol	53.57 (4.85)	68.71 (5.82)	15.14 (3.97)	28%*****
C group	59.57 (13.17)	60.62 (12.82)	0.87 (1.72)	1%
Leg press (kg)				
DP protocol	144.57 (54.99)	253.28 (81.25)	108.71 (39.24)	75%
RS protocol	135.85 (19.70)	208.42 (14.87)	72.57 (14.05)	53%
C group	144.25 (30.48)	147.62 (29.17)	3.37 (2.32)	2%

Average increase in muscle strength in terms of percent, in order for three groups of double-pyramid, reverse-step and control, for upper body muscles were; 28.87%, 28.26%, and 1.45%; and for lower body muscles were: 75.19%, 53.41% and 2.33% respectively. As shown in table 3, in muscular endurance test for lower body muscles, the difference between the 2 training groups and the control group was significant, and this significance was greatest for the reverse step group; however, the difference between two groups of double-pyramid, and reverse step in upper body was not significant. Average increase in muscle endurance in terms of percent in the order of group mentioned were; 90.08%, 88.26%, and 4.08%; and for lower body were; 58.70%, 68.51%, and 7.29%. The results of muscular mass indicated that no significant difference existed between training groups. However, the difference between two groups of training and control group was significant.

TABLE 3. The mean (SD) endurance pre and post loading protocols and % change in each of these variables.

	Pre protocol	Post protocol	Change in mean (SD)	% change
Bench press (rep)				
DP protocol	15.28 (5.49)	29.38 (6.18)	14 (3.91)	90%
RS protocol	20.71 (4.46)	39 (5.65)	18.28 (2.13)	88% *****
C group	18.37 (2.72)	19.12 (2.58)	0.75 (1.16)	4%
Leg press (rep)				
DP protocol	23.85 (6.28)	37.85 (6.69)	14 (1.82)	59%
RS protocol	28.14 (5.36)	47.42 (6.52)	19.28 (1.70)	69%
C group	25.62 (3.85)	27.5 (2.72)	1.87 (1.45)	7%

Average increase in muscular mass in terms of percent, in order of groups mentioned, for upper body were; 3.12%, 2.17%, and 1% (table 4).

TABLE 4. The mean (SD) cross sectional area (CSA) pre and post loading protocols and % change in each of these variables.

	Pre protocol	Post protocol	Change in mean (SD)	% change
Thigh (mm)				
DP protocol	11.01 (8.28)	15.36 (9.97)	4.34 (2.33)	6%*
RS protocol	11.06 (8.30)	14.30 (7.74)	3.24 (0.76)	4%*
C group	11.37 (11.78)	12.38 (11.46)	1.17 (0.74)	0.5%
Arm (mm)				
DP protocol	273.81 (41.47)	284.66 (41.43)	3.76 (10.85)	4%
RS protocol	263.11 (12.92)	274.03 (10.97)	10.91 (3.23)	4%
C group	263.39 (25.79)	246.21 (24.92)	0.82 (1.96)	0.3%

Studying the statistical test for "leg-power" indicated that no significant difference existed between the 3 groups; however, the difference between two groups of double-pyramid, and reverse step was significant. The average increase in jumping after training in order for double-pyramid, reverse step and control were; 7%, 4%, and 3%, respectively.

TABLE 5. The mean (SD) maximum power output and mean power pre and post loading protocols and % change in each of these variables.

	Pre protocol	Post protocol	Change in mean (SD)	% change
Maximum power output (W)				
DP protocol	3522.82 (1011.8)	3781.65 (971.66)	258.82 (99.23)	7%*
RS protocol	3480.68 (404.17)	3642.38 (406.52)	161.7 (94.17)	7%*
C group	2924.15 (572.61)	3000.53 (559.93)	79.38 (85.80)	3%
Mean power (W)				
DP protocol	1231.2 (532.57)	1338.9 (518.29)	107.7 (35.06)	9%
RS protocol	1230.48 (253.61)	1296.78 (255.7)	66.38 (35.19)	5%
C group	979.76 (328.45)	1007.92 (323.41)	28.16 (23.17)	3%

DISCUSSION OF RESULTS AND CONCLUSIONS

In this study, the results of 1RM strength test did not indicate any significant differences between the two training groups on upper and lower body muscles; however, this difference was significant for the control group. Also, a greater increase was observed in the DPLP group. Based on the theory of a repetition maximum (RM) continuum, heavier training loads (e.g., 2–6RM) have commonly been used to induce fatigue with the goal of increasing strength via central fatigue (7). Mirzaei et al (2011) suggested that muscular fatigue increases by performing more sets in heavy resistance exercise (like DPLP in this study). Although, it is claimed that, RSLP with maximal load in first set and reduced load in next sets with increased repetitions causes muscle fatigue and maybe lead to muscle overcompensation (2), it seems that, DPLP with maximum loads and more sets lead to more motor unit requirement and increasing strength.

Other finding in present study was in muscular endurance, for lower body muscles, the difference between the 3 groups of training was significant, and this significance was more for the benefit of RS group; however, the difference between two groups of DP, and RS in upper body was not significant. Local muscular endurance has been shown to improve during resistance training (17). As the athletes enhance their maximum strength, they also take advantage from improvements in other performance characteristics of neuromuscular function such as power (30, 31) and endurance (27). The training resistance influences the number of repetitions that can be performed, which, in turn, provides the stimulus related to changes in muscular strength and muscular endurance. The classic study on adults done by DeLorme (1945) suggests that heavy resistance–low repetition protocols provide muscular strength, whereas low resistance–high repetition protocols result in muscular endurance. In agreement with other studies, our research demonstrates that, low resistance–high repetition protocols (RS) are more effective than heavy resistance–low repetition protocols (DP) for developing muscler endurance.

Also, we observed no significant difference among training groups muscle mass. However, the difference between two groups of training and control group was significant. It is well known and understood that resistance training induces muscular hypertrophy (17). Despite with primary claims that said, DPLP is more effective for muscle hypertrophy (2), mean increase in muscle mass in two training groups were approximately same (2% priority for DPLP in lower extremity). Practitioners commonly use lighter training loads (e.g., 8–12RM) to elicit hypertrophy via a peripheral response in the muscle (29). Kraemer et al (2000) showed that, heavy loads are suitable for increasing muscle mass (as load in RSLP group) (20), this repetitions refers to using 60-85% of 1RM. Resistance training programs targeting muscle hypertrophy utilize moderate to very heavy loads and are typically high in volume (16). However, by 6–7 weeks of training, muscle hypertrophy becomes evident (24). Studying the statistical test for "leg-power" indicated that no significant difference existed between 2 groups of training; however, the difference between two groups of DPLP, and RSLP was significant. Siegel (26) indicates that, power training needs 70% loads. Coaches and athletes are well aware that the type of resistance training they select will influence strength, power, endurance, weight, and many other parameters to different degrees (28). Two protocols that were used in this study enhanced power and jumping height. Small difference between RSLP and DPLP groups may be due to more increase in strength and hypertrophy in DPLP group.

In conclusion, it seems that using two applied models of training were suitable for increasing strength, endurance, muscle mass and muscular power; and almost have similar increase in physiologic factors of the athletes. However if our purpose is increasing strength along with increasing muscular endurance, the reverse step model is more appropriate.

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LES EFFETS DE DEUX MODELES DIFFERENTS DE CHARGE RESISTIVE SUR LA FORCE, L'HYPERTROPHIE, LA PUISSANCE ANAEROBIE ET L'ENDURANCE DE JEUNES LUTTEURS

RÉSUMÉ

La présente étude examine les effets de deux types de charge dans l'entrainement aux charges résistives. Un schéma de chargement à double pyramide (DP) et un modèle de chargement inverse (RS) ont été utilisées pour étudier leurs effets sur certaines capacités physiologiques des jeunes lutteurs. A cet effet, 22 lutteurs sont portés volontaires pour y participer. Les sujets (âge 17,30 ± 2,42 ans; hauteur 170,41 ± 6,14 cm, poids 72,29 ± 13 kg, et BF% 12,39 ± 7,39) avaient au moins 6 mois d'entrainement en lutte. Les sujets ont été divisés au hasard en 3 groupes: un groupe témoin (n = 8), et deux groupes d'entrainement aux charges résistives: un groupe en utilisant l'entrainement en DP (n = 7), et un groupe utilisant l'entrainement en RS (n = 7). Les sujets se sont entraînés pendant 8 semaines en utilisant deux modes de chargement sélectionnés. En DP, les sujets se sont entrainés ainsi: 4/80%, 3/85%, 2/90%, 1/95%, 1/95%, 2/90%, 3/85%, 4/80%. En RS, les sujets se sont entrainés ainsi: 2/90%, 10/70%, 15/60%, 2/90%, 10/70%, 15/60%. Pour étudier les variables, le test ANOVA et le test de Tukey post-hoc ont été utilisés. Les résultats d'une épreuve de résistance 1RM n'ont pas révélé de différences significatives entre les deux groupes de formation supérieure et sur les muscles du bas du corps, mais cette différence était significative pour le groupe témoin (P ≥ 0,05). Dans un test d'endurance musculaire pour les muscles du bas du corps, la différence entre les 3 groupes était significative, et cette signification était plus élevé pour le groupe RS, mais la différence entre les deux groupes de formation de DP et RS dans le haut du corps n'était pas significative (P ≥ 0,05). Les résultats concernant la masse musculaire ont indiqué qu'aucune différence significative n'existait entre les groupes de formation. Cependant, la différence entre les deux groupes d'entrainements et le groupe témoin était significative (P ≤ 0,05). Le test statistique pour "la puissance musculaire des jambes", n'a indiqué aucune différence significative entre les 3 groupes, mais la différence entre deux groupes de DP et RS était significative (P ≤ 0,05). En conclusion, il semble que les deux modèles de formation, ont pu être montée en puissance, l'endurance, la masse musculaire et la force musculaire, et presque avoir des avantages

similaires à des facteurs physiologiques des athlètes. Toutefois, si le but est en augmentant la force avec l'augmentation d'endurance musculaire, le modèle RS est plus approprié.
MOTS-CLES: Lutte, entrainement aux charges résistives; entraînement à double pyramide; entrainement étapes inverses.